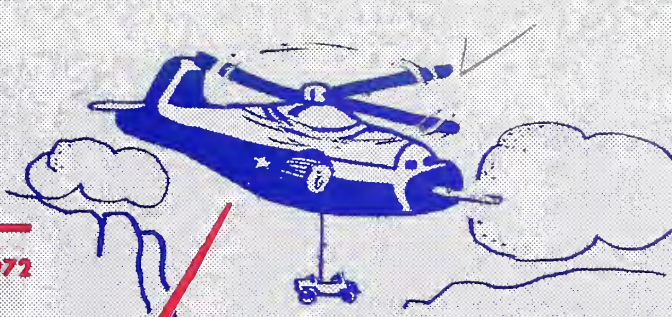
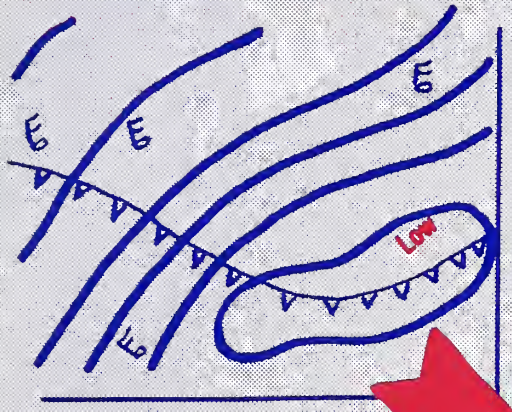
ARMY RESEARCH AND DEVELOPMENT

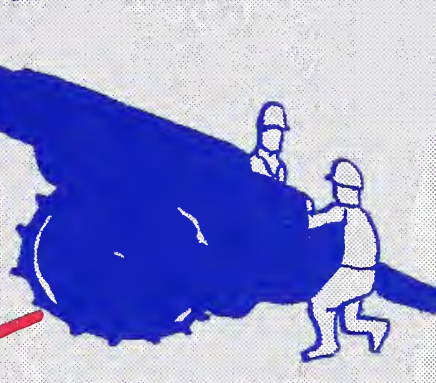
September 1972



LOCAL DATA ON WEATHER RESTRICTIONS TO AIR OPERATIONS

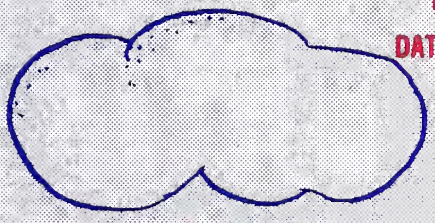


AIR WEATHER SERVICE REPORTS



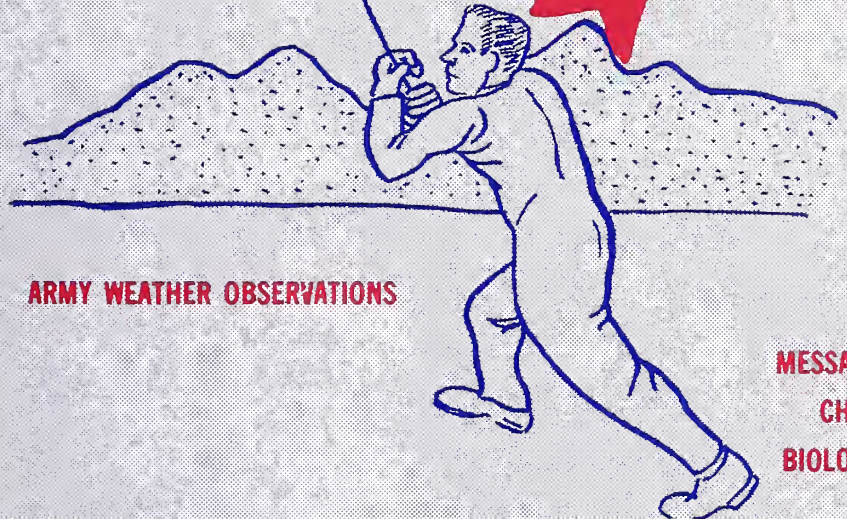
FIELD ARMY DATA PROCESSING

IMPROVED MET MESSAGE FOR ARMY FIREPOWER



AUTOMATIC METEOROLOGICAL SYSTEM Page 28

TRAFFICABILITY MET MESSAGE



ARMY WEATHER OBSERVATIONS

MESSAGE OF NUCLEAR CHEMICAL AND BIOLOGICAL HAZARDS

IN RETROSPECT . . .

Atomic Clocks Essential to Space-Age Developments Evolved From Army Signal Laboratories' Joint Effort WOSAC Study

"Atomic clocks get around a lot these days, what with synchronizing our spacecraft tracking stations and linking the time scales of large radio-telescopes for studies of stellar radio emissions."

The quotation comes from a recent Department of Commerce release on the role of the National Bureau of Standards (NBS) in using atomic clocks—mounted as passengers about once every year in jet aircraft traveling from the United States to France—to fix the infinitesimal difference between the American atomic time scale and the international atomic time scale maintained in Paris.

The news release prodded the memory of the editor of the *Army Research and Development Newsmagazine,* to the degree that he recalled an article carried in our December 1960 edition about the completion of Project WOSAC. The concluding paragraph stated:

"Full analysis of several hundred yards of data recorded during the tests has now been almost completed. U.S. Army Signal Laboratory scientists are confident that a global system of synchronized atomic clocks could be put on an operational basis within two years—and even greater accuracy attained."

Project WOSAC was undertaken by the U.S. Army Signal Laboratory (which on Aug. 1, 1962, became the U.S. Army Electronics Command) in cooperation with Prof. J. A. Pierce of Harvard University, the U.S. Air Force Rome Air Development Center, the U.S. Naval Electronics Laboratory and the British Post Office. It was divided into:

(1) Synchronizing an atomic clock mounted in an airplane with a master clock; (2) synchronizing all "slave" clocks with the flying clock; (3) maintaining synchronization of slave clocks through phase tracking of VLF transmissions controlled by the master clock.

Test flights to achieve these objectives totaled 72,000 kilometers (45,000 miles) in a military version of the Boeing 707, operating in east-west and north-south conditions to take into consideration electromagnetic factors.

Perhaps that initial feature article still ranks as one of *Army Research and Development Newsmagazine's* most important reports of an R&D development of great significance, achieved as a cooperative

(Continued on page 34)

GREAT MEN OF AMERICAN HISTORY are shown nearly half a century ago in this picture "resurrected" from his wife's family album by Dr. Harold A. Zahl, who was Director of Research at the U.S. Army Electronics Command when he retired in January 1966 with 35 years Federal Civil Service. Shown (l. to r.) are Harvey Firestone Sr., President Calvin Coolidge, Henry Ford, Thomas Edison, Mrs. Coolidge, President Coolidge's father and (standing) Harvey Firestone Jr. Dr. Zahl, who now lives the good life at the "Hazienda," a farm that backs up against the RCA Laboratories in Holmdel, N.J., reports that his latest book, Radar Spelled Backwards, *is doing well in sales and that SIGNAL magazine soon will publish his satire on Civil Service retirement.*

ABOUT THE COVER:

Various aspects of a new system being developed to improve the Army's capability of observing and predicting small-scale weather conditions are depicted on the front cover. Called the Automatic Meteorological System, it is designed to acquire through a computer system all met data available and disseminate it in different formats to users.

A typical artillery metro section is depicted on the lower half of the back cover, showing components of the Meteorological Data Sounding System. At the top, a graph displays some of the major efforts of the over-all meteorological program and the respective time frames in which each will be fielded.

Editor . . . . . **Clarence T. Smith**
Associate Editor . **George J. Makuta**
Associate Editor . . . **Philip A. Farris**

Published monthly by the U.S. Army R&D Information Systems Office, Office of the Chief of Research and Development, Department of the Army, Washington, D.C. 20310, in coordination with the Technical and Industrial Liaison Team, OCRD. Grateful acknowledgment is made for the valuable assistance of Information Offices within the U.S. Army Materiel Command, U.S. Continental Army Command, U.S. Army Combat Developments Command, Office of the Chief of Engineers, and Office of the Surgeon General. Use of funds for printing of this publication has been approved by the Department of the Army, May 1, 1970.

Purpose: To improve informal communication among all segments of the Army scientific community and other Government R&D agencies; to further understanding of Army R&D progress, problem areas and program planning; to stimulate more closely integrated and coordinated effort among Army R&D activities; to express views of leaders, as pertinent to their responsibilities, and to keep personnel informed on matters germane to their welfare and pride of service.

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Submission of Material: All articles submitted for publication must be channeled through the technical liaison or public information officer at installation or command level.

By-lined Articles: Primary responsibility for opinions of by-lined authors rests with them; their views do not necessarily reflect the official policy or position of the Department of the Army.

ARMY RESEARCH AND DEVELOPMENT

Vol. 13, No. 6 **September 1972**

FEATURES

DEPARTMENTS

DISTRIBUTION is based on requirements submitted on DA Form 12-4. Army agency requirements must be mailed to the U.S. Army AG Publications Center, 2800 Eastern Boulevard, Baltimore, Md. 21220.

Distribution on an individual name basis is restricted to members of the U.S. Army Atomic Energy and R&D Officer Programs and to R&D Mobilization Designees. Otherwise, distribution is made only to the Army installation, office or organizational element to which the requester is assigned.

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Selective Scanner . . .

Fan-in-fin Device May Replace Tail Rotor

A fan-in-fin antitorque device may replace the conventional tail rator on Army rotary-wing aircraft if praved feasible in research under a $2.1 millian cantract awarded recently by the U.S. Army Air Mability Research and Develapment Labaratory, Fort Eustis, Va.

Sikorsky Aircraft is expected to demanstrate the feasibility af the directional cantral system as compared ta canventianal tail ratars for stability, contral, weight, pawer requirements, and aver-all aircraft performance.

Substituting a buried ducted fan for the canventional tail ratar is expected ta result in greater reliability, reduced maintenance, reduced hazards to graund persannel and decreased vulnerability ta terrain ar tree cantact damage. The cancept also affers advantages for high-speed ratary-wing aircraft, in that it is less susceptible to highspeed instabilities.

While cansiderable study and analysis has been canducted ta improve the aver-all perfarmance of the antitarque device, the first productian unit is a ducted fan called the Fenestron. Used an the SA-341 Gazelle, it was designed and develaped in France by the Saciete Natianale Industrielle Aeraspatiale.

Data fram the Aeraspatiale Fenestran develapment effart has been callected, tabulated and analyzed as part of the U.S. Army's current R&D pragram.

U.S. Army research will encompass ground and flight tests for structural integrity of the fuselage; also, fan blade natural frequencies, and functianal testing af all fan engine and rotor controls.

In flight tests, quantative data will be derived on directional contral power, stress and vibratian, aver-all aircraft stability and cantral, and flight envelape baundaries.

The cantractar will recommend the aircraft to be used in the feasibility tests, expected ta be campleted in 2-3 years.

LRPDS Mobile Units Scheduled for October Tests

Engineering acceptance testing af the mabile Long Range Pasitian Determining System—under off-and-an develapment far mare than a decade as a taal for artillery requirements, with numeraus ather patential applicatians—is scheduled ta begin in October.

Described in detail in a feature article in the September-October 1970 editian af the *Army Research and Develapment Newsmagazine*, the LRPDS when campleted is expected ta have up to 30 mabile graund receiver units. Total cast of the praject is estimated at appraximately $4 million.

An airbarne campanent transmits signals to as many as 30 ground units, three of which must be lacated at knawn pasitians. A graund-based central processing facility computes positions of the up ta 27 unknawn receivers.

The LRPDS is expected to lacate friendly caaperating stations ta an accuracy of 10 meters horizantal and 10 meters vertical. Potential applications ather than far artillery requirements include the location of ground farces, determining aircraft positions in connection with aerial photography, perfarming third and passibly even secand-order surveys, and measuring distances.

Completion of the acceptance tests is scheduled for the secand quarter af FY 1973 fallawed by engineer service tests extending to the secand quarter af FY 1974. Type classification af the system is anticipated in late FY 1974.

Carl Friburg and Steve Nagy are manitoring the praject far the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Va. The Matarala Government Electronics Divisian, Scattsdale, Ariz., is develaping the mobile receiver units, 10 af which will be used in the test program.

Army Conducting Final Tests on Improved Hawk

The U.S. Army is taking a final look at the Improved Hawk missile befare deplaying the up-dated air defense system worldwide. In a 90-day test, the Air Defense Board at Fort Bliss, Tex., is canducting a thorough evaluatian, with a study of haw saldiers in the field wauld operate and maintain the system.

Considered three tests in ane, the first phase deals with Initial Praduction Testing ta determine if the Impraved Hawk is suitable for Army use. A Phase II is an independent evaluatian by the Air Defense Agency. Finally, the Air Defense Center team is carrying aut an Expanded Service Test of the Improved Hawk Assault Fire Unit (Impraved Platoon Command Post).

Included on the test team are 16 NATO abservers fram countries where the basic Hawk system is deployed, and five Marine Carps evaluatars.

The Improved Hawk, designed ta meet the more saphisticated threats af the 1970s, features a new guidance package embodying transistors, integrated circuits and salid-state components; a larger warhead; and an improved matar prapellant.

In addition, much of the graund support equipment has been autamated. An electranic data processor assists saldiers in target engagements and a built-in trauble shooting capability simplifies maintenance. Missiles go directly fram the productian line to the launcher as a "certified round." No maintenance or tests an missiles are required at the Fire Unit ar direct suppart level.

The first basic Hawk battalian was activated in 1960. Since that time, Hawk has staad guard with the Army and Marine Corps, bath in the United States and averseas.

The Basic Hawk was praduced in Eurape by a consartium of five NATO countries and is being coproduced in Japan.

WSMR Tests Simulate Mars Lander System Deceleration

Deceleratian conditians expected when NASA's Viking Lander vehicle descends on Mars in 1976 were achieved in recent high-altitude tests abave White Sands (N. Mex.) Missile Range.

In the secand af three scheduled flight tests af the parachute system that will decelerate the Viking Lander, a large helium-filled ballaon lifted the simulated entry vehicle to an altitude af about 121,000 feet above the range. The vehicle was then drapped an radia signal fram the cantrol center and rocket motars ignited ta boast it ta about 135,000 feet.

Atmaspheric density canditians at that altitude achieved simulation af thase expected when the Viking Lander gaes inta the deceleration phase for the actual landing an Mars in 1976.

The test terminated when the simulated vehicle landed via parachute about 35 miles narthwest af Halloman Air Force Base an White Sands Missile Range 3 hours and 17 minutes after lift-aff.

The purpase was to check the parachute system at transonic canditians and at the lawest parachute loading canditions expected aver Mars. Preliminary analysis indicated that all test canditians were met and all systems operated as anticipated.

NASA plans ta launch the unmanned Viking vehicle in 1975 to achieve a saft landing on Mars in 1976.

Navy's TALOS Missile Being Modified for Joint Service

TALOS, a Navy air-defense missile, is being modified for use as a low-altitude supersanic target (LAST) for the Army's SAM-D missile system and the Navy's Aegis missile.

The Defense Department has assigned the Army development responsibility far the TALOS-LAST pragram, with the Navy participating. The pragram is designed to satisfy Army and Navy LAST requirements at minimum cost.

The U.S. Army Missile Command, Huntsville, Ala., has awarded a $1.8 millian contract to Bendix Corp., although the tatal cantract is worth $2,165,830. Bendix will modify the TALOS missile, do preliminary ground tests on subsystem proto-

type hardwore, and conduct limited flight tests. Further flight tests will be conducted at the White Sonds, N. Mex., ond Pocific Missile Ronges.

Prototype System Economically Monitors Pollutant

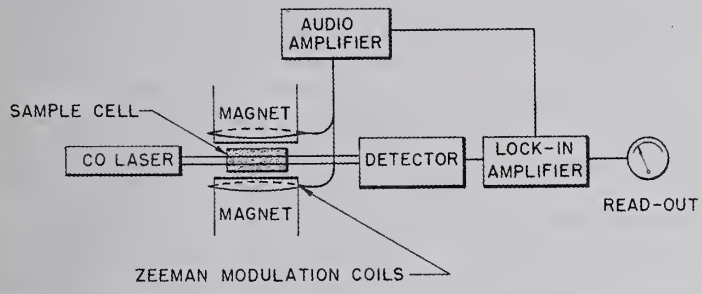
Nitric oxide emissions from such sources as outo exhousts ond electrical power plont stacks can be monitored more economicolly ond simply by using a new National Bureou of Standards prototype system.

The procedure, not subject to interference from other contominants in the sample, achieves a sensitivity of three ports per million. Further refinements ore onticipated by NBS scientists.

The prototype monitor is based on the Zeeman shift of o nitric oxide absorption line into coincidence with a CO laser line. A static mognetic field, supplied by on electromagnet (or on oppropriote permanent mognet) of 750 gouss shifts the nitric oxide absorption line into near coincidence with the laser line.

A small coil driven by on audio amplifier generates o moduloting magnetic field, sweeping the obsorption line through the laser line, eliminoting the need for a tunable loser. An infrored detector's output signol is proportionol to the amount of nitric oxide in the sample.

Nitric oxide is a major air pollutont and is the precursor to nitrogen dioxide, the trigger molecule in photochemicol smog formation. When high levels of this pollutant are present, eye irritation ond other discomforts are severe.



Two Beehive Rounds Nearing Type Classification

Two additional Beehive ammunition rounds, each filled with thousonds of flechettes about 1½ inches long, are expected by Picatinny Arsenal, Dover, N.J., to be type classified soon for use in M60 ond M48 tank guns.

Type classification means Department of the Army occeptonce and represents ocknowledgement by both the developing commond and combot user that o round of ommunition meets performonce requirements.

In this instance, requirements were estoblished by the Combot Developments Commond (CDC) to counter tactical operotions in Southeost Asia when mossive concentrotions of enemy troops were thrown into combot.

Conventional munitions were not sufficiently effective ond CDC's requirement colled for stepped-up firepower.

The Beehive has 5,000 flechettes assembled as a tape in one round of ommunition. Each flechette has four fins which stabilize its flight.

Beehive refers to the way the flechettes ore arronged in comportments in the shell similor to the honeycomb of a hive of bees. An advantage of this round in Vietnam has been thot it functions neor the muzzle, os a shotgun, ond olso can be set to spew the flechettes ot ony desired point down ronge to the maximum range of the weapon.

Magnesium Melting Technique Study Proposed

Additional research of o new approach to magnesium melting, which employs oir ond smoll percentoges of sulfur hexofluoride os its protective otmosphere, is being proposed to raise the fluxless technique to a commerciol level.

The Columbus (Ohio) Laboratories of Battelle are proposing o 2-year research project that would be set up as a joint venture with at least 10 companies sharing in the costs (estimated at $160,000) ond benefits of the study.

Preliminary objective is to estoblish the conditions necessary for melting magnesium alloy scrap in the air/sulfur hexafluoride atmosphere to ottain cleon metol and low melt losses.

The process will be carried out initially in a 140-pound melting unit and loter scoled up to o 1,200-pound immersion-tube-heoted furnoce which can be run os o bulk melter for both ingot ond scrop.

Doto will also be obtained to determine the protection copobilities of oir/sulfur hexofluoride mixtures ot temperotures greoter thon 700° C. This is necessary to confirm that the atmosphere can be used for high-temperature alloying ond is compotible with sond costing practice.

Director of Bottelle's Magnesium Reseorch Center, H. Russell Ogden, soid: "The goseous otmospheres used to dote in ottempts to eliminote flux hove proved to be less thon satisfoctory. The new technique promises not only a consideroble reduction in magnesium conversion costs but olso significant melt floor improvements in sofety and working conditions."

STRATCOM Adds AUTODIN Link in Korea

A computerized communications center at Taegu, Koreo, is scheduled to begin operating Dec. 30 under the Army's Strotegic Communications Commond (STRATCOM).

One of 19 Switching Centers locoted in the United Stotes and overseos os port of the Defense Communicotions System, the Taegu AUTODIN (outomotic digitol network) will become another link in a network that has o daily tronsmission copobility of 3.8 million 80-character line blocks at rotes up to 6,000 words per circuit.

Currently transmitting 300,000 written messoges a day, os well os processing punched cards and tape, the system operotes on a store-and-forward bosis, permitting worldwide messoge tronsmission in seconds.

The Toegu AUTODIN Automatic Switching Center will link Department of Defense orgonizotions ond other federol ogencies with such command ond control centers as STRATCOM's Pentogon Telecommunications Center.

Watervliet Managing 60mm Mortar Development

A new lightweight 60mm company mortar, designoted the XM224, is now the systems monogement responsibility of Wotervliet (N.Y.) Arsenal where it will be produced for Army and Marine Corps use.

Presently in the advanced development phase, the XM224 is scheduled for full-scole development this foll.

The system will reploce the 81mm mortor used ot Infantry compony level, and will hove improved firepower and mobility. It is expected to increose combat effectiveness where monportability of weapons is a primary requirement.

This multimillion dollor proiect—the first ossigned to Wotervliet for a system monagement role—will be corried out in conjunction with Frankford Arsenal, which has responsibility for fire control; Picatinny Arsenol, for ommunition; Harry Diomond Laboratories, for fuzing; ond the U.S. Army Test and Evoluation Commond, for testing operotions.

Senate Action Proposes Big Increase in Civilian Research

Expenditure of $1,025,000,000 over a 3-year period is proposed in a "National Science Policy and Priorities Act of 1972" that would energize the power of science and technology in an assault upon critical social and economic problems in specific areas.

Currently, the U.S. Government expenditure for research and development is at a level of about $13,900,000,000 annually, with roughly half of this total going to military R&D. One of the eventual objectives of the Act would be to increase funding of civilian research to about the level of military R&D.

Passed by the U.S. Senate by a 70 to 8 vote and referred Aug. 18 to the House Committee on Science and Astronautics, the Act would amend the National Science Foundation (NSF) Act of 1950, and establish within the NSF a Civil Science Systems Administration. Specific goals include:

- Providing productive jobs for currently unemployed and underemployed scientists, engineers and technicians.
- Initiating research and demonstration programs in areas such as housing, nutrition, poverty relief, health care, pollution control, energy production, communications, transportation, educational technology, public safety and crime-fighting.
- Creating new technologies that would result in each research worker accounting for seven new jobs. (Objectively, this would utilize fully the nation's manpower pool of scientific and engineering talent.)

One of the expanded responsibilities of the NSF through the Civil Science Systems Administration would be to identify priority areas of civilian research and engineering likely to help resolve problems in listed areas.

Section 104 authorizes the NSF to make grants to, or enter into contracts with, appropriate organizations for basic and applied research and engineering in priority areas.

Under Title II, the NSF is authorized to initiate and support programs which use science, technology, and advanced analytical techniques to design civil science systems that provide improved public services.

To carry out this program, the Civil Science Systems Administration, headed by an associate director appointed by the President and modeled on the National Aeronautics and Space Administration, will be authorized and directed to:

- Initiate and support programs of applied research and experimentation;
- Test and evaluate alternative civil science systems and appraise the results;
- Disseminate and demonstrate results of the civil science systems programs so they may be utilized in developing new communities and improving living conditions in existing communities;
- Assure that the programs make maximum effective use of scientists, engineers and technicians, including those who are unemployed.

In addition to the associate director, a deputy associate director and two assistant directors will be appointed by the President to conduct the Administration's functions.

A Civil Science Systems Advisory Council would be established, composed of 31 members. Eighteen would be appointed for 3-year terms from among the following categories: business, labor, engineers, design professionals and natural scientists, social and behavioral scientists, environmental and other community groups, and consumers.

While serving on Council business, each appointed member would be entitled to compensation not to exceed the daily rate prescribed for a GS-18.

Ten of the 13 proposed ex-officio members would be: the Associate Director for Civil Science Systems; Assistant Secretary of Commerce for Science and Technology; Assistant Secretary of Health, Education and Welfare for Health and Scientific Affairs; Assistant Secretary of Housing and Urban Development for Research and Technology; Administrator of the National Aeronautics and Space Administration; Chairman of the Atomic Energy Commission; Assistant Secretary of Transportation for Systems Development and Technology; Administrator of the Environmental Protection Agency; Director of the Office of Economic Opportunity; and the Chairman of the Council on Environmental Quality.

The remaining three would be representatives designated respectively by the National Governors Conference, National Association of Counties and, jointly, the National League of Cities and U.S. Conference of Mayors.

The Council will advise the National Science Foundation director on his responsibilities under this law, review and evaluate the effectiveness of Federal programs, prepare and submit to the director interim and annual reports of findings and recommendations, and disseminate them to the extent considered advisable.

Another section of the Act authorizes the National Science Foundation to plan and assist in the transition of scientific and technical manpower from research and engineering programs, which have been terminated or reduced, to other civilian-oriented activities.

To implement this provision, an Advisory Panel on Transition of Scientific and Technical Manpower to Civilian Programs would be made up of 31 members, 18 appointed for three years and 13 designated ex-officio members.

The Act states that appointed members will be chosen from among experienced individuals in engineering and natural sciences, economics and social sciences, industry, labor, public affairs, education, manpower training, and unemployed scientists, engineers and technicians.

Calling for the annual election of a chairman from among the appointed members, the Act stipulates that the Panel wll meet at his call but not less than four times a year.

Functions of the Panel, under Title III, are similar to those specified in the Act for the Civil Science Systems Advisory Council under Title II, their respective areas of interest differing in scope and objective.

Title III encompasses research on transition to civilian programs, assistance to state and local governments, training of government officials, government employe participation, community conversion corporations, job transition programs, career transition fellowships, placement assistance, and education programs.

A final category in the Act, under Title IV, concerns the protection of pension rights of scientists and engineers. As a result of frequent employment changes, engineering and scientific personnel suffer a uniquely high rate of pension benefit forfeiture under private pension plans.

Offsetting this situation, the Act stipulates that "Congress declares it is the policy of the United States to seek to protect scientists and engineers from such forfeitures by making protection against forfeiture of pension credits, otherwise provided, a condition of compliance with Federal procurement regulations."

Air Force Smart Bombs

Army Research Yields Laser-Guided Missile Technology

The Army missile engineer takes a handful of newspaper clippings from a drawer and hands them across the desk.

"Look at this. The Air Force guided one bomb right up the mouth of a railroad tunnel," he says as he sorts through the clippings for another example.

The story is about "smart bombs." All the clippings tell of the almost incredible accuracy laser-guided bombs are demonstrating in the air war over North Vietnam—accuracy that the Secretary of the Air Force recently said made it possible for one tactical fighter to accomplish "what 25 might have done in the past."

The intense interest one civilian missile engineer and many of his colleagues in the research and development organization of the U.S. Army Missile Command at Redstone Arsenal have in news accounts of the combat success of the first laser-guided weapons is understandable.

His name is David J. Salonimer. He has been working on laser guidance concepts and techniques for the Army since 1961. Many of the men who worked with him insist Salonimer was the key man in the successful effort to pioneer the concept, technology and experimental hardware subsequently used by the Air Force in the development of the laser-guided smart bomb.

The Army missile team makes no claim to paternity, but the smart bomb has a host of proud uncles at Redstone. Their work from the outset was aimed at laser-guided weapons that could be used by the Army.

In developing them, they devised and proved a guidance concept applicable to bombs, rockets, missiles, even artillery shells, then transferred what they had learned to their Air Force counterparts. How MICOM scientists assisted the Air Force in bringing along the smart bomb provides a classic example of how problems solved by one research team can give another a running start.

Widely hailed by laymen as a potential wonder weapon almost from the moment more than a decade ago when it was first demonstrated in the laboratory, a laser converts electrical energy into a very narrow, coherent beam of light, light of extreme brightness.

Despite the predictions of those who said the advent of the laser in 1960 meant a death ray lay just around the corner, there were—and still are—major technical problems involved in using lasers as weapons.

Early models required enormous electrical power to operate, but the special properties of the laser beam aroused immediate interest.

Dr. John L. McDaniel, director of Missile Command research and engineering, recalls: "Many people in our business could see that the laser might be a way to do something. The trick lay in finding a practical application for it."

The something that interested Army missile engineers and others in the defense industry looked to be the answer to a particularly tough problem. By the early 1960s ways had been devised to guide missiles to hit tanks so long as the man who fired the missile had the tank in sight. The next step: finding a way to hit a tank when it was out of sight of the man who fired the missile.

A possible solution involved using some distinctive characteristic of the tank itself that a missile guidance system could recognize and home on—the way a heat-seeking missile steers itself to the heat given off by an airplane engine. For a variety of technical reasons, that approach failed.

Problem solvers then began searching for a way to mark the target. What they wanted was a means to project a distinctive signature on the tank that a missile guidance system could recognize. Radio, radar, infrared and a host of other technical approaches were tried. All failed.

David J. Salonimer

Beginning in 1961, Army missile engineers at Redstone evolved a concept and theory of laser semi-active guidance. Reasoning that advances in laser technology soon might make it possible to project the laser beam over sufficient distances to meet military requirements, they proposed using a laser as an illuminator, a means to mark the target by projecting a bright spot of light upon it.

If that could be done, they were reasonably sure that a seeker could be built that could see the spot on the target and guide a missile to it. The thing looked possible on paper, but the key elements needed to make a laser-guided weapon, the illuminator and the seeker, had yet to be built.

In 1962 as the group at Redstone continued their investigations, the illuminator loomed as the toughest problem. Soldiers on the battlefield would need a device that could be easily moved. The portability the Redstone group knew the Army would insist upon dictated not only an operating laser but a relatively small one, hopefully a device and its related power supply that could be carried by one man.

Allan A. Norman, then a team leader in the Missile Command element charged with investigating potential future missile systems, recalls it as a time when one idea after another would be advanced, argued over and discarded. There was general agreement that to be useful to the Army, a laser illuminator and its power supply—probably batteries—would have to weigh no more than 40 pounds.

Norman asked Salonimer to take a look at how that might be done. Salonimer, then a 38-year-old general engineer with six years experience in the Army missile program, had recently completed a survey of existing and proposed missile guidance concepts. A graduate of Wayne State University, he had a solid background in electronics, circuitry and servo technology.

Dr. Julian Kobler, who worked in the same group, recalls: "Dave was up to speed on current guidance technology. Beyond that, he had read every technical article on every subject he could get his hands on. He has a unique ability to synthe-

(Continued on page 32)

WES Develops Technique of Low-Cost Highway Construction

How about your innovative "Roads in a Raincoat" concept—what has happened since the first experiments were made a couple of years ago?

To that recent question an Army Corps of Engineers official responded: "Well, you know they are building quite a stretch of road at Fort Hood, Tex."

Early in August a follow-up response to the inquiry came in the form of a news release describing how the Fort Hood road at the main entrance was constructed, using the MESL (membrane encapsulated soil layer) technique. The cost is estimated at about 50 percent of conventional flexible pavement.

Merrill Kreipke, chief of the Terrestrial Sciences Branch, Environmental Sciences Division, Army Research Office, Office of the Chief of Research and Development, inspected the new road. The MESL base, he reported, was strong enough to support a 2-inch, high-density, bituminous hot-mix wearing course.

One of his conclusions is that the MESL technique "appears to have considerable promise for use in low-cost construction of conventional roads at U.S. Army facilities." The Fort Hood road traffic load will be about 1,000 vehicles a day, 10 percent of which will be 18,000-pound axle load or greater vehicles.

The basic principle of the technique is that the soil itself will support military cargo vehicle traffic if moisture is sealed off. This is accomplished by wrapping native soil between membranes joined and sealed along the edges to form a waterproof soil system. Only plastic membrane, fabric asphalt and native soil are required.

Fort Hood's road was built in this manner: equipment removed the soil that formed the foundation layer; a grader smoothed the subbase surface; polyethylene sheets, each 100 by 32 feet, were spread by hand on the subgrade; front-end loaders placed the soil on the lower membrane; a grader spread the soil, leaving the lower membrane edges exposed for bonding with the upper membrane.

After being carefully impacted,

NEW ROAD arrives by truck in neat bundles.

Equipment removes soil used to form foundation layer.

Grader smooths subgrade surface.

Polyethylene sheets are spread on the subgrade.

the soil received a light spray coating of rapid-setting, emulsified asphalt. The surface layer was placed in one operation, using an asphalt distributor with a simple laying yoke for unrolling the fabric—a random fiber polypropylene material of about five denier and weighing about four ounces a square yard.

(The fabric comes in rolls 15½ feet wide and 350 feet long, each weighing less than 200 pounds. Since all the materials are flexible, going around bends and up and down hills present no problems in construction.)

Upper and lower membranes were then bonded, with the edges buried later as shoulders of the road. A final application of asphalt was applied and the surface blotted with sand, leaving the MESL ready to serve as the base course and the fabric and asphalt as the pavement surface on a secondary road. To meet requirements for a primary road carrying both civilian and military vehicle traffic, a 2-inch surface of hot-mix asphalt pavement was placed over the MESL.

Building of the test road at Fort Hood meets another goal in a research program started several years ago by the Army Engineers Waterways Experiment Station, Vicksburg, Miss., to provide the military with a construction technique when aggregates required for conventional road-building methods were not available.

Lack of materials for roads in Southeast Asia, particularly the Mekong Delta, influenced the Office of the Chief of Engineers to seek another method. The MESL road system offers a solution, while cutting work, cost and time.

A demonstration road, 1,600 feet long and 20 feet wide, was built at the Waterways Experiment Station in June 1970. Laid out on a slope in the shape of a figure eight, it includes curves, an intersection, and a hillside. Subjected to over 2,000 coverages of military vehicles up to 5-ton trucks over a period of two years, the road remains in good operating condition despite repeated flooding from a nearby creek.

(Continued on page 8)

Front-end loaders place soil on lower membrane.

Grader spreads soil, leaving lower membrane edges exposed for bonding with upper membrane.

Light-spray coating of rapid-setting emulsified asphalt is applied.

Final application of asphalt, later blotted with sand, goes on the polypropylene, which can absorb asphalt 270 times its weight.

WES Develops New Technique Of Low-Cost Road Construction

(Continued from page 7)

Ability of the top membrane to support traffic was evaluated using a completely automated, circular test facility. Traveling at a speed of 30 miles per hour, the rig spins around the circular track every 10 seconds, applying rolling wheel traffic on the surfacing. In one hour it applies the equivalent of a day's traffic for a road subjected to moderate vehicle density.

A test of the ability of an aggregateless foundation to support aircraft involved the use of 12 special wheels on an experimental strip. The wheels had the configuration of the landing gear of the C-5A, the largest military plane in existence. Each of the tires, inflated to 100 psi, carried a weight of 30,000 pounds. The result of this series of tests, representing a 750,000-pound total weight aircraft, indicated this material is a satisfactory foundation for heavy aircraft.

Demonstration MESL road at WES.

DoT Allocates $4 Million for College Research

A new program of university involvement, directed to solution of intermediate and long-range transportation problems, was discussed at a Sept. 22 Department of Transportation Conference on University Research Opportunities.

Funded at $4 million during its first year, the program will provide a new point of contact at the level of the Secretary of Transportation between the Department and the academic community. It will support problem-oriented interdisciplinary, multimodal and intermodal mission research by faculty and graduate students.

Accredited institutions of higher education which offer baccalaureate and graduate degrees in fields relevant to transportation may participate.

Research funded under the program will complement rather than supplement or replace existing modal university research under way in the operating administrations of the Department which, during fiscal year 1972, was of the order of $11 million.

Some of the objectives are:

• To stimulate relevant, high-quality and innovative transportation research at universities for the creation of new concepts, techniques and knowledge, and for the development of highly skilled professionals in transportation.

• To increase the effectiveness of universities in helping to solve local, state and national transportation problems.

• To encourage the use of modern tools of analysis, planning and management, new technology and of professionally trained people by state and local transportation agencies.

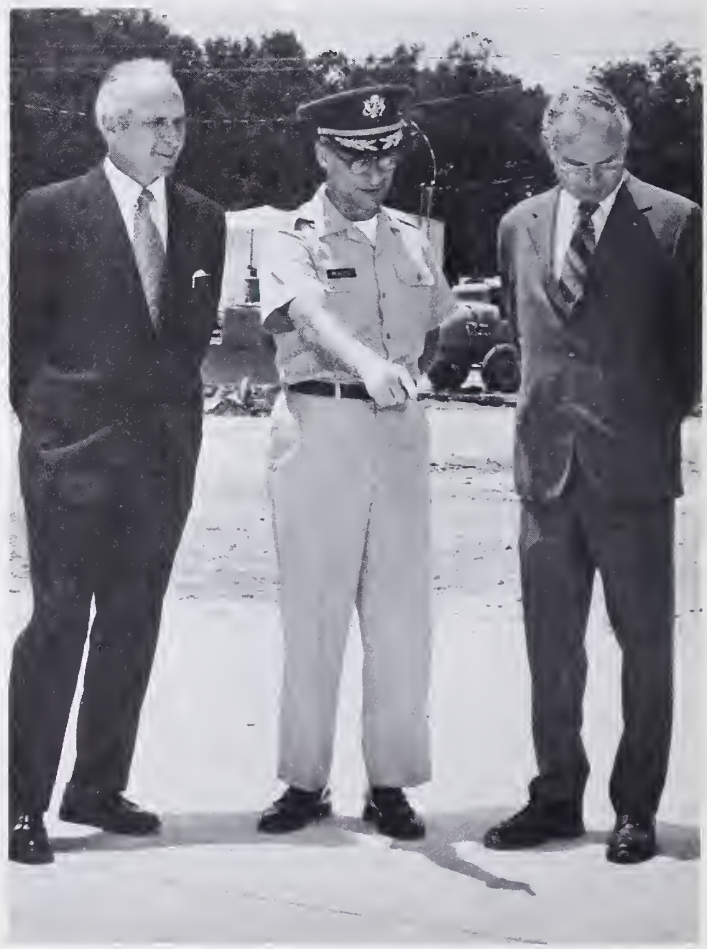
• To stimulate industry and state and local agency sponsorship of university-based transportation research.

• To assess the demand for professional manpower in transportation and to project future training requirements.

Contracts under the program will be awarded on a competitive basis to qualified educational institutions based on professional merit and relevance of the proposed research and on the qualifications of the investigators.

Conference discussion reflected the thought expressed by President Nixon in his Mar. 16, 1972, message on science and technology when he said:

"We must appreciate that the progress we seek requires a new partnership in science and technology—one which brings together the federal government, private enterprise, state and local governments and our universities and research centers in a coordinated, cooperative effort to serve the national interest."



NEW PAVEMENTS FOR SATELLITE BASING PROGRAM was one of the research projects inspected by Assistant Secretary of the Army (R&D) Robert L. Johnson (right), during a visit to the U.S. Army Engineer Waterways Experiment Station at Vicksburg, Miss. Discussing the program for building new bases for the B-52 plane are J. P. Sale, chief of the Soils and Pavements Laboratory, and COL E. D. Peixotto, WES director, as they stand on a new strip of rigid pavement. The runway strip includes stabilized soils, plain concrete, fibrous reinforced concrete, foamed plastic insulating materials to cut down frost penetration below the pavement, and the new membrane encapsulated soil layer (MESL) method of construction.

Running parallel to the rigid pavement, a strip of flexible pavement is under construction using various thicknesses and types of stabilized base and sub-base layers surfaced with asphaltic concrete. Both strips of pavement will be subjected to simulated traffic of the B-52 to determine the requirements for this plane, which has a 488,000-pound load and a landing gear requiring thicker pavements. This is part of the short-range airfield pavement research program for improving Corps of Engineers' heavy duty pavement design and construction to utilize new materials in cost reduction.

Corollary Applications . . . Concept of 'Roads in a Raincoat' Serves Airfields, Tested on Roof

Corollary applications of the basic principle of "Roads in a Raincoat," described on pages 6-8, are under development or are being considered at various Army R&D installations.

The concept involves use of a heavy membrane as a moisture seal to protect a native soil surface when used for roads or airfield requirements. One of the newest applications is constructing leak-proof roofs on buildings.

Membrane Set, Heavy-Duty, Airfield Surfacing XW18 was type classified Standard A by the Army in June 1972. Consisting of six parts which can be used in varied combinations, the set provides dustproofing and waterproofing for runways, taxiways, parking aprons, warm-up aprons, helipads and heliports.

Reportedly a major improvement to its forerunner, the T-17 membrane, the XW18 was developed to withstand the stresses placed by Air Force C-130 aircraft at touchdown and turn areas. Medium and light-duty airfield membranes are currently in development.

The XW18 membrane is a neoprene-coated, 4-ply nylon fabric with skid-resistant compounds and runway striping on the surface. Developmental work was done at the U.S. Army Waterways Experiment Station (WES), Vicksburg, Miss., with participation from the U.S. Air Force Tactical Air Command, XVIII Airborne Corps, and the U.S. Army Test and Evaluation Command. Uniroyal, Inc., Mishawaka, Ind., contracted for production of the membrane.

INSTALLED EXPERIMENTALLY at the U.S. Army Cold Regions Research and Engineering Laboratory (USACRREL), Hanover, N.H., is a new type of flat roof construction that utilizes a waterproof membrane laid on a concrete roof deck, a water-resistant and water-impermeable insulating material, and protective paving slabs.

CRREL engineer Haldor W. C. Aamot (right) supervises construction of a protected membrane test roof at the laboratory.

The membrane provides the same waterproof construction offered in standard roofs. The insulation is laid on the membrane to protect it from stresses of temperature extremes and sunlight which deteriorate most membrane materials, in addition to providing the desired indoor thermal protection. Concrete slabs hold the roof components in place and provide protection for the insulation.

Instrumentation has been provided in the USACRREL experimental roof to permit study of stress responses during the coming winter. Haldor W. C. Aamot, a research mechanical engineer, and David Shaefer, a research civil engineer, are conducting the study.

PLASTEC Extends to Industry Information Needs

Responding to a new Department of Defense policy, PLASTEC (Plastics Technical Evaluation Center) at Picatinny Arsenal, Dover, N.J., is disseminating information to private industry for a fee as a new source of funding.

PLASTEC was one of 28 Information Analysis Centers (IACs) set up in 1960 as authoritative sources to assist in accomplishing Department of Defense programs. Originally they were created as information sources on a variety of technical subjects for use only by government and defense contractors.

Recent cuts in the defense budget, however, have forced the IACs to look for new funding sources. One result is the dissemination of information to private industry with a charge.

PLASTEC charges $25 an hour for its work, and is one of the few IACs that are 50 percent self-supporting—a figure the Department of Defense has ordered for all IACs.

Henry Pebly Jr., PLASTEC director, said that early industry response to this new policy has been encouraging. He listed Kodak, Schick, Hercules, S. C. Johnson, Bethlehem Steel, Hallmark, and General Electric as some of the companies that have come to PLASTEC for information on a fee basis.

Pebly stressed that PLASTEC is not a document warehouse. When a company wants information on a particular phase of plastics, the PLASTEC staff prepares an individual study using the documents only as source material. A thorough evaluation of all data is made before a report is completed.

"If all a company wants is a certain report, they can get it at either the Defense Documentation Center or the National Technical Information Service," Pebly said.

At the beginning of this year, PLASTEC was given the added mission of covering plastic-based adhesives (such as epoxy) and organic matrix composites (such as nonmetallic helicopter blades). At the present time, 5 to 10 percent of all documents at PLASTEC are on adhesives and 35 percent on composites. Plans call for development of a computerized system to provide data needed for selection of polymeric materials.

Memorandum of Understanding

Cooperative research between the Air Mobility Research and Development Laboratory (AMRDL) and the Office National D'Etudes et de Recherches Aerospatiales is the purpose of a recent Memorandum of Understanding between the United States and France.

Dr. W. J. McCrosky of the AMRDL, a leading U.S. authority on basic helicopter aerodynamics, is assigned to ONERA for one year ending in September 1973. Blade dynamics and basic rotorcraft blade boundary layer flow are being studied in the joint effort. Upon conclusion of Dr. McCrosky's visit to ONERA, it is anticipated that two French scientists from ONERA will be assigned to AMRDL for six months each.

OCRD Mobilization Designee Promoted to BG

Dr. John H. Neiler, whose Reserve Officer Mobilization Designee assignment is assistant to the Army Chief of Research and Development, was promoted to brigadier general rank Aug. 15, with CRD LTG William C. Gribble Jr. and Mrs. Neiler pinning on his stars.

BG Neiler joined the Office of the Chief of R&D MOBDES program in December 1971, 28 years after he was commissioned in the Infantry as a second lieutenant. He is vice president and director of technical planning for instruments, Oak Ridge Technical Enterprise Corp., a subsidiary of Edgerton, Germeshausen and Grier, Inc.

After attending the Infantry School and Parachute School during World War II, he served progressively in the European Theater as platoon leader, battalion S-2, and executive officer, 3d Battalion, 517th Parachute Infantry Regiment, then as S-2 of the 517th and 505th Parachute Infantry Regiments.

Returned to civilian life in June 1946, he continued his education at the University of Pittsburgh, receiving a BS degree in engineering and physics in 1947, MS in 1950, and a PhD in physics in 1953.

BG Neiler has combined an active professional career with duty in the U.S. Army Reserve. After transferring to the Signal Corps in 1950, he was promoted to major in 1955. In 1960 he attended the Associate Signal Corps Advanced Course and the U.S. Army Command and General Staff College. Promoted to lieutenant colonel in 1963, and colonel in 1969, he served during this period with a variety of Reserve units in research and development activities. From 1965 until his assignment to OCRD in December 1971, General Neiler had a MOBDES assignment with the Army Materiel Command.

Conversion of Waste Material to Antipollution Fuel Discussed

Development of technology to convert cellulose (waste paper and many similar forms of waste material) into glucose products such as sugar, syrup and clean-burning fuel was announced early in 1971 by the U.S. Army Natick (Mass.) Laboratories. The story was featured on the front page of the Army Research and Development Newsmagazine.

Dr. Carl Lamanna, deputy chief and scientific adviser of the Life Sciences Division, Army Research Office, Office of the Chief of R&D, is the author of an article in the July 1972 edition of ASM News, *published by the American Society for Microbiology, that elaborates on possibilities of this source of clean-burning fuel.*

Permission has been granted to reprint the article, "Microbial Activity as a Source of Renewable Nonpolluting Fuels," as follows.

By Dr. Carl Lamanna

In the public discussion of the energy crisis, there has been a neglect of thought given to microbiological possibilities for solutions to the problem. This is an oversight that microbiologists should do their best to counter. There are challenging possibilities for production of renewable sources of nonpolluting fuel by microbiological means.

As long as the sun shines, photosynthesis will provide substrates that bacteria and other microbes can convert to clean fuel. The most nonpolluting fuel, according to presently available combustion technology, is methane. A properly directed imaginative research effort can result in the discovery of bacteria and other microbes which, alone or in proper association, can convert cellulose, the main product of photosynthesis, largely into methane. Combustion of methane for its energy content returns carbon dioxide and water to the atmosphere for recycling by photosynthesis. The marriage of microbiology with fuel technology has promise of producing ecologically balanced offspring. The proponents of solar energy for solving the fuel crisis should not neglect microbes as a means for making some significant fraction of solar energy trapped by photosynthesis available as a combustible fuel. This is the incontrovertible scientific rationale for microbiologists to demand a place in governmental and industrial efforts seeking new and nonpolluting fuel sources of energy.

Thinking about microbial sources of methane has focused on urban sewage. Yet, to the microbiologists, it is evident that methane can be derived biologically from many more sources than sewage alone. Other imaginative ideas for research and development are worthy of exploration. For example, it should not be neglected that a major component of rubbish and garbage is cellulosic products and that animal wastes in the poultry and dairy industries, which present serious disposal problems, are convertible to methane as a source of power on the farm. It should be feasible to develop economically promising self-contained fermentors producing methane from such wastes. The spent medium of such a fermentation is rich enough in nutrients or could be fortified to be used as fertilizer or animal feed supplements so as not to pose a serious disposal problem.

Why not go a step further? Why should not farmers raise certain crops for fuel instead of for food? It is not necessary to think of agricultural sources of fuel simply as a by-product of food production. This could be a new direction for agriculture, namely, raising crops genetically selected for optimal production of cellulosic or other carbohydrate readily convertible to methane by microbiological processes. In a nation where food surpluses are an economic problem, and where it has been increasingly difficult to provide economic incentives for farm-oriented people to stay on the farm, it makes good social sense to develop entirely new directions for agricultural enterprise.

Admittedly, the task of developing an economically sound system of agriculture based on crops raised specifically for conversion to nonpolluting fuel would require long-term research in agronomy and botany. While this is going on, our already far-advanced fermentation technology could be developed to the stage of practical production of methane from cellulose, by working with sources of waste cellulose already available in large tonnage. Two such products are bagasse from the sugar cane industry and sawdust and other waste products from the lumber and paper-making industries.

A handful of microbiologists, such as E.T. Reese and Mary Mandels and their colleagues at the U.S. Army Natick Laboratories, have already demonstrated the feasibility of the economically promising conversion of cellulose to monosaccharide by enzymatic means, utilizing purified cellulase from fungi. This work originated in attempts to produce glucose from waste cellulose. One could go some steps further in the fermentative breakdown of cellulose by conversion of the glucose to alcohol or methane.

As a fuel source, methane production may have a practical advantage, though not a thermodynamic one, over alcohol production. As a gas, methane separates itself by diffusion from the fermenting mass and could be easily led off for storage in pure form to be fed, as required, into already existing pipeline and other transportation systems for delivery to methane consumers, whether these be public utilities or individual households. Thus, in the methane fermentation, there is no need to devise processes for extraction of the product from the fermenting mass, and the infrastructure already exists for distribution to the consumer.

While the production of methane from cellulose has been stressed, this is only to illustrate concretely the more general notion of the scientific validity of probing for ecologically satisfying and economically practical microbiological means for development of new fuel sources. Given free reign and the necessary wherewithall, microbiologists can explore an abundance of worthwhile ideas as yet uninvestigated. Undoubtedly, new sound ideas would be stimulated by such a program. What is needed to get such programs underway is public and official recognition of microbiology as a science able to contribute in significant ways to solving the energy crisis.

What I have hoped to emphasize, in particular, is that microbiology can contribute to a new direction for agricultural output. Microbiologists must encourage interest in thermodynamic studies of fermentations of farm produce as fuel source. Microbiologists must insist that parallel economic studies of utilization of microbial fuel sources be done with a realistic view of the ecological advantages of microbial activity not easily reducible to dollar cost estimates. Potentialities, both anticipated and unanticipated, exist for microbiological fermentation to contribute, in socially meaningful nonpolluting ways, to the supply of a basic need, the need for renewable fuel sources for energy.

R&D NEWS . . .

AMMRC Builds 'Clean Room' For Optical Items Processing

"Clean Room" evaluation and processing of glass and plastic materials used in transparent prototype items such as windshields and eyeshields is being accomplished in a new facility of the Army Materials and Mechanics Research Center (AMMRC), Watertown, Mass.

A high degree of optical quality, such as required for field items, is possible with the new facility. Processing of transparent materials at the AMMRC previously was concerned chiefly with ballistic performance.

Two rooms provide a combined work area of about 650 square feet. In the first chamber the temperature, humidity and particulate contaminents are closely controlled, using a conventional vertical air flow design.

Classed as a semi-clean conditioned chamber is a second room where only humidity and temperature are controlled. Both rooms are joined by a common air-lock providing access to the main building.

The 2-chamber design is explained by the sequence of functions required in processing transparent laminates. The normal work flow is from the clean room, where conditioning and assembly of laminates is initiated, to the semi-clean room for completion of autoclave molding.

With the clean room and semi-clean room under a positive pressure, a 7- by 7-foot connecting room serves primarily as an air lock and secondly as a change room.

Upon entering from the main building area (after thoroughly cleaning off clothes and shoes), personnel change into clean garments and plastic overshoes. A locker is provided for the storage of these items. In addition, a tack mat in front of clean room door assures that any dust on plastic overshoes may be removed before entering the clean room.

The Clean Room is maintained at a temperature of 71–74°F. and a relative humidity of 18-22 percent. This low humidity, required for the processing of moisture-sensitive adhesives and plastics, assures improved optical quality and interlaminar adhesion. It is achieved by a continuously reactivated, noncycling, solid-dessicant type dryer.

Three positive filters, having a total face area of 12 square feet, remove 99.9 percent of all particles more than 0.5 microns. Contamination from opening the doors is prevented by the positive pressure in the room.

A minimum of 130 cubic-foot-per-minute make-up air, supplied independently of the main air handling system, assures an adequate supply of fresh air even if the air handler shuts down.

Modular construction allows disassembly of the clean room and erection at another location if moving becomes necessary. Panels are insulated with a fire-retardant urethane foam.

The floor is surfaced with a conductive linoleum (resistance of 75,000 ohms) to help eliminate static charges. These are an inherent problem at humidities of less than 30 percent, in that freshly cleaned plastic surfaces can attract stray particles of dust.

AMMRC's CLEAN ROOM is shown here being used during optical quality testing of transparent plastics. Richard Ames, chemical engineer (left), is making haze measurement on a plastic specimen. Verne Stimpert tests new coating for scratch resistance.

Three 36- by 30-inch windows supplement an already adequate lighting system and allow observation of the clean room interior from the main building area (safety reasons). An emergency door is provided in addition to the entrance from the air lock.

For the evaluation of individual components and molded laminates for optical quality, a Kollmorgen model D-1 combination colorimeter/spectrophotometer and a Gardner model AUX-10 Hazemeter are available.

Specific clean room processing functions include conditioning, cleaning and assembly of glass, plastic and adhesive materials into a pre-bagged lay-up; heat forming of plastic sheet to specific curvatures; and the preparation and application of adhesive films and primers.

Formulation and application of special adhesives and primers which may be toxic are carried out in a glove box. Port holes in the walls are provided for venting the glove box and the heat-forming oven as well as introducing dry nitrogen or argon for purging purposes.

The Semi-Clean Room is maintained at a temperature of 72–76°F. and a relative humidity of 26–32 percent. Although there is no positive filtration of incoming air, except through standard fiberglass filters, the room is tightly sealed and under a positive pressure to help eliminate introduction of airborne contaminants from outside the room.

Functions carried out in this room are limited mainly to preparation of the unlaminated assembly for the autoclave. This includes bagging and heat-sealing operations to enclose the lay-up in a vacuum-tight envelope, and evacuation of air with a vacuum pump.

In some instances, a vacuum oven conditioning cycle is used to assure a more efficient removal of air and other volatiles from between the layers of materials.

The room is also used to store glass and plastic sheet materials, special molds and tooling, bagging and heat-sealing materials, as well as miscellaneous items used in the various stages of processing.

With AMMRC's new ability to maintain standardized processing conditions, it will be possible to screen candidate component materials for laminates quite closely for optical quality.

USAIDR Examines New Drugs For Minimizing of Scar Tissue

Seeking to alleviate the problem of keloid disfiguration, the United States Army Institute of Dental Research (USAIDR) is experimenting with several drugs which act as collagen antagonists.

Collagen is the extra fibrous material laid down by the body as a result of "overzealous healing." A keloid is a dense fibrous tumor of the skin, occurring usually at the site of an injury and consisting of an overgrowth of scar tissue.

When a keloid occurs in the area of the face and neck, it may be sufficiently disfiguring to change a person's personality and outlook on life.

"A keloid looks like a light pink rope lying on the skin," a USAIDR researcher explained. "The collagen antagonists would prevent the excessive growth of scar tissue and the scar would remain flat and normal appearing."

USAIDR researchers also are working on a standard air-pressurized multiple injection gun that would introduce the collagen antagonist directly into the keloid.

An interesting sidelight to the keloid problem is that keloids are used by some Australian and African natives as *ornamental* patterns of raised scars on the body.

Nitinol . . .

Army Studies 'Metal With a Memory' for Dentistry

Implanting teeth, freezing gums, and using Nitinol, "the metal with a memory," for dental clasps are among techniques currently being developed by the United States Army Institute of Dental Research (USAIDR).

In relation to the implant tooth program, LTC Robert Johnson, chief of the Dental Research Division, U.S. Army Medical R&D Command, recently reported: "We believe we have found the optimum root structure design and now have many of those structures firmly implanted in the jaws of laboratory animals."

He said that the program is moving to the occlusion phase where the implants will be put into function by taking an impression of the structure in place, in the same manner as used when preparing human teeth for fixed bridgework.

A clinical crown is prepared and the entire structure is put into function as a normal tooth. Success in the experimental program could mean that professional productivity will be doubled, since one-half the clinical appointment time will be required to replace the missing teeth.

Although teeth have been implanted successfully in humans in civilian dentistry, principally in Boston, Mass., the Army is convinced that such implants are tested insufficently. Studies of implants in laboratory animals to improve techniques used in civilian dentistry will continue for two to three years at USAIDR before moving to the clinical phase.

A cryogenic technique has been developed by USAIDR to relieve distress of soldiers using dentures. A significant number maintain poor oral hygiene beneath dentures and develop a hyperplastic condition of the palate that becomes so painful they cannot eat properly and are inactive in their unit for as long as three weeks.

This tissue previously had to be surgically removed by cold knife electracautery, causing the patients considerable pain and requiring a long healing period during which the patients could not perform duty.

Using the new cryogenic technique already being applied to soldiers, the painful area is frozen and the dentures can be immediately reinserted. The patient returns to duty and following simple home care, his mouth will be normal in two to three weeks.

NITINOL, known as the metal with a "memory" is finding many uses in dental research. Developed by the Naval Ordnance Laboratory, this alloy is 55 percent nickel and 45 percent titanium. Nitinol can be programed to assume a particular shape at any desired temperature by alternation of its atomic configuration.

Stronger, harder, and tougher than other metal used in dentistry, Nitinol has been used in humans in the form of self-locking denture clasps and self-adjusting orthodontic appliances which eliminate the need for many return visits to the clinic.

Research conducted thus far only in animals has utilized Nitinol in the form of self-anchoring surgical pins, self-adapting surgical mesh, and self-locking surgical rivets.

Tissue studies have proven its biocompatibility and therefore it appears that the use of Nitinol for medical applications is limited only by imagination, said LTC Johnson.

William Buehler, an NOL metallurgist employed at White Oak, Md., accidentally discovered the peculiar qualities of Nitinol. Several years ago, while searching for a nonmagnetic and noncorroding material to be used in tools for dismantling magnetic mines, he learned how Nitinol could be "manipulated" by temperature control programing of a desired configuration. Development of this metal reportedly is paying off in applications for construction of aircraft and submarines.

Experts Grant Lance Missile 'Seal of Approval'

Major components of the Lance battlefield missile system have been recommended by a panel of Army missile experts for type classification Standard A.

This decision to award Lance the Army's "seal of approval" was reached at a Lance Development Acceptance/Production Validation In-Process-Review held at HQ Army Missile Command, Redstone (Ala.) Arsenal.

The panel's recommendation has been sent to higher headquarters for further action. Standard A means that a weapon system has been thoroughly tested and is judged to be suitable for Army use, and normally precedes production and deployment.

Meeting with representatives from all Army agencies concerned with Lance development, the voting panel, which included three general officers, determined that the Lance missile (minus nuclear warhead) and Ground Support Equipment have met major Army requirements and should be type classified Standard A.

A decision was made to extend limited production of the warhead until additional engineering-service tests are completed.

The panel also recommended that the Lance Guided Missile System Test Set (GMSTS) undergo modifications before getting Standard A.

Scheduled to replace both the Sergeant and Honest John missiles, Lance is a highly mobile weapon system that can destroy enemy troop concentrations, supply depots, transportation routes and similar targets. It has maximum ground mobility, a swim capability, and can be transported by plane or air-dropped.

The voting panel included MG Roderick Wetherill, CG of the Army Field Artillery Center and School; BG Albert G. Hume, CG of the Army Combat Systems Group, Combat Developments Command; BG Robert J. Proudfoot, Lance project manager, and COL R. L. Branch, Army Logistics, Doctrine, Systems and Readiness Agency, Office of Deputy Chief of Staff for Logistics.

FIBERGLASS FILAMENT WINDING PROCESS, developed in Watervliet (N.Y.) Arsenal's Physical Science Division to protect gun tubes from thermal effects, engages the attention of MG Henry A. Rasmussen (left), CG, U.S. Army Weapons Command (WECOM), and COL Christopher S. Maggio, arsenal CO. The filament is wound around a mandrel, then separated and slipped over a conventional steel tube. The process minimizes bending created when the tube is exposed to solar radiation, thus reducing the loss of accuracy that occurs in a tube unprotected by the fiberglass "shroud."

R & D NEWS

U.S. Army's Long Study of Surgical Electroanesthesia Turns to Consideration of Device Developed in France

With a new type of electroanesthesia developed in France and being evaluated at the United States Army Institute of Dental Research (USAIDR), Washington, D.C., what appears to be a reclining person wearing eyeglasses could be a patient awaiting surgery.

LTC Robert M. Johnson, chief of the Dental Research Division, U.S. Army Medical R&D Command, has witnessed operations on humans under electroanesthesia in France. A European investigator later demonstrated his methods on laboratory animals at USAIDR.

A simple eyeglass-type device under development permits the patient to relax in a reclining position while surgery or dental work is performed. No pain will be experienced and recovery from anesthesia will be immediate when the equipment is turned off, LTC Johnson said.

In the eyeglass type of electroanesthesia, the patient is exposed to a very low direct electric current via a cathode located between the eyebrows and two anodes attached behind the mastoids.

The Journal of the American Medical Association reported recently on operations in France in which electroanesthesia was sufficiently deep to allow operations lasting over two hours and analgesia lasted up to 24 hours. The patients reportedly had no memory of the operation, no pain relievers were needed for the first 24 hours after surgery, and no adverse side effects were elicited.

Following maxillofacial injury in combat or field activities, LTC Johnson cited the possibility of a small reusable battery-pack electroanesthesia appliance being quickly employed while the patient is comfortably moved to where operative procedures can be performed, without the requirement of any additional anesthetic support.

"In comparison with large amounts of conventional materiel required for present anesthetic techniques," he said, "these small reusable devices could save millions of dollars. More importantly, they could allow increased efficiency and increased professional productivity."

USAIDR is presently experimenting with electroanesthesia on laboratory animals in evaluating the improved technique. The Army Medical R&D Command has been investigating electroanesthesia under contracts with various investigators since the early 1960s.

Invisible Energy Sources Utilized for Soil Studies

Fascinating images of great value to engineers and scientists exist on and beneath the earth which cannot be seen by the human eye or detected by conventional photography.

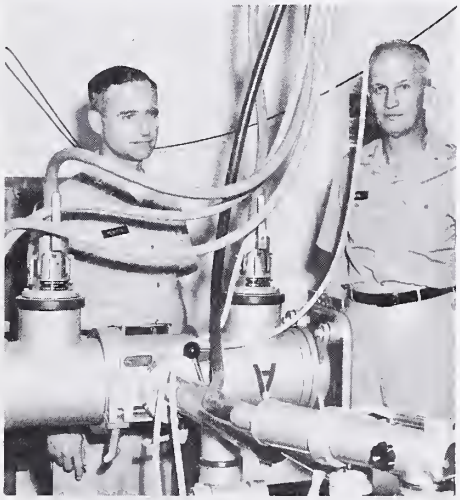
Geologists at the U.S. Army Engineer Waterways Experiment Station have pioneered in the technique of using invisible energy sources, such as heat and sound, to photograph soils features that were once invisible.

One means of examining soils is with X-ray radiography—the use of penetrating radiation to produce shadow images of the internal structure of materials. The method is nondestructive and can be done rapidly, using either X-ray film or a fluorescent screen. It is particularly valuable because X-rays register very slight changes in density and composition of materials.

The techniques of geology are employed and geological knowledge applied to military engineering projects with success. Radiography is being used to develop a clearer understanding of the ability of bullets and shell fragments to penetrate fine-grained soils. Compressional waves built up by these ballistic fragments show up quite plainly as variations in soil density when X-rayed.

An example of a practical application of radiography in defining depositional environments and their characteristics was in connection with a levee settlement investigation in the Atchafalaya River Basin of Louisiana. The ability of X-rays to pick up from undisturbed borehole samples the very fine details of weak spots caused by roots, burrowing animals, organic matter and other factors made it possible to pinpoint the causes of failure and provided a key of what to expect when building structures or embankments in swampy areas.

Radiography offers a tremendous potential as a routine test procedure. With as many as 3,000 undisturbed cores a year coming in from the field for examination, the specimens can be scanned unopened to provide a radiographic log for use in selecting samples for laboratory tests.



BG Wayne S. Nichols (right), director of Military Engineering, Office of the Chief of Engineers, inspects an X-ray machine that makes radiographs, showing structural details that could not be seen by the naked eye, and would not show up in a conventional photograph. COL Ernest D. Peixotto, director of the U.S. Army Engineer Waterways Experiment Station, accompanied the general on a tour of the extensive laboratory facilities used in research and testing in hydraulics, soils and pavements, concrete, mobility and environment systems, weapons effects, and explosive excavation.

Army Studies Sewage Disposal With View to Fertilizing Land

Feasibility of disposal of sewage treatment plant wastewater on land—where nitrogen and phosphorous can become a fertilizing resource, rather than a threat to the ecosystem when discharged into rivers and lakes—is being studied in a U.S. Army project.

Investigative efforts are being conducted by a multidisciplinary group of scientists and engineers from the staff of the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (USACRREL).

Current efforts are based on a study report prepared by a team of USACRREL experts who made an intensive 1971 assessment of various techniques of sewage disposal on land throughout the United States.

The survey objective was to provide a more complete definition of ecosystem responses and provide a basis for more effective and economical designs of sewage disposal systems, geared to military installation requirements as well as to those of large cities.

The current concept is that land treatment of wastewater, involving filtration and other responses by soil microorganisms, can provide total renovation, meanwhile enriching the land for more productive farming.

A special test facility is being constructed at USACRREL, Hanover, N.H., consisting of closed-cycle sites on which wastewater from a sewage disposal facility will be disinfected and then sprayed.

By use of six concrete test cells, each 28 feet square and six feet deep, all liquids applied to the contained soil will be collected and returned to the municipal sewage disposal system—after the effluent has been tested at different levels as it filters to the bottom of the test cells. The cells will be filled with the various types of soil found near six metropolitan areas.

Hopefully, results of the research will prove suitable for wide application in the improvement of sewage disposal techniques throughout the U.S.

Reference Work on Technology Effects Annotates 300 Information Sources

A reference work on effects of technology—xerography, microforms, computers, facsimile—on copyright has been published as *Technology and Copyright: Annotated Bibliography and Source Materials.*

The publication by Lomond Systems, Inc., is an annotated and classified bibliography of 300 references published since 1967. Reprinted reference materials by authorities on the subject include selections by Barbara A. Ringer, Stephen Breyer, Walter Pforzheimer, Launor F. Carter, Arthur J. Greenbaum, Charles A. Lieb, William M. Passano, Harold E. Wigren and others.

The complete citation is: George P. Bush, editor, *Technology and Copyright: Annotated Bibliography and Source Materials.* October 1972. About 400 pp. Index. ISBN 0-912-338-03-2 (clothbound); ISBN 0-912-338-04-0 (microfiche). Hard copy: $14.50; microfiche: $9.50.

Army Tests of Veteran Aircraft Provide Basis For Design Improvement Under RAM Program

Aircraft that have been in Army use for many years, including combat service in Vietnam, are being thoroughly tested by the U.S. Army Aviation Test Board at Cairns Army Air Field, Fort Rucker, Ala.—to the astonishment of many visitors expecting to see testing of the exotic, advanced models.

Why test Hueys, Cobras, Chinooks, Cayuses, Kiowas and Mohawks—aircraft that have been proved in the field for hundreds of thousands or even millions of hours? The answer is in the Army's Product Improvement Test Program which is a part of the high-priority Reliability, Availability and Maintainability (RAM) Program.

The T53-L-13B turbine engine that powers many Hueys and Cobras initially had a time between inspections (TBI) of 300 hours and a time between overhauls (TBO) of 1,200. Since those standards were set, RAM efforts at Fort Rucker have:

- Effected technical improvements that have substantially extended the service life of many components.
- Resulted in advanced technology and more reliable criteria for testing equipment.
- Reexamined inspection procedures to determine whether requirements are excessive or unrealistic.

In examining the old TBI and TBO of the T53-L-13B turbine engine, for example, they were tested for 1,800 or more hours in controlled flight test situations while loaded with water ballast to constitute maximum gross weight. Three engines were flown more than 3,000 hours each and one operated successfully for 4,218 hours between overhauls.

As a result of the test program, the TBI of the T53-L-13B turbine engine was increased from 300 to 900 hours and the TBO from 1,200 to 1,800 hours. These new schedules not only represent vast savings in maintainance expenses; they also effectively increase the number of aircraft available for Army use.

Testing of the L-13B engine is continuing, with a goal of achieving a TBI of 1,200 hours and a TBO of 2,400 hours. Such programs are intended not only to improve the cost-effectiveness of the fleet at a time of austere military funding, but also to influence future engine design.

AERONAUTICAL ENGINEER Flutcher J. McCrory examines engine components during a "hot end" inspection at the U.S. Army Aviation Test Board lab facilities.

R & D NEWS

DoD Schedules Release Of MIDI Radar System

Scheduled for delivery in January 1973 is a new projectile vector Miss-Distance (MIDI) Radar measuring system that will provide test data previously unattainable and with an improved 100:1 data throughput.

MIDI Radar is one result of a continuous search within the Department of Defense for ways and means of reducing the time frame and cost of developing new weapons systems. It is an example of how improvement in instrumentation facilities and methods can result in substantial savings during the test and evaluation phases.

The MIDI Radar embodies a ground-based system and reportedly will offset effectively the limitations of currently used optical instrumentation.

Determination of round-by-round vector miss-distance when firing 20mm nontracered ammunition, at rates of fire up to 3,600 rounds per minute, is a performance specification. The system also will measure projectiles that miss the target by as much as 50 meters.

Anticipated improvements in shortening the R&D cycle for new air defense guns and missiles is based primarily on the near real-time data reduction capability of the MIDI Radar, as compared with the lengthy data reduction time required when using optical/photographic instrumentation.

Historically, vector miss-distance information has been collected by optical instrumentation which has the inherent limitations of:

- Sophisticated test range facilities are required to support the effort.
- Excessive time is required for the reduction and analysis of photographic data.
- The rate of fire capability is considerably below that required for existing weapons.
- Testing is limited to fair weather daylight hours.
- Gun testing is limited to tracer ammunition only.
- Missiles must be large enough to permit photographic image recording at extended ranges.

A comparision between the two methods shows an improved data throughput of 100:1 accompanied by a personnel requirement reduction of 20:1. The cost savings possible through use of the MIDI Radar system have been estimated at $800,000 per annum.

MIDI Radar development is supported by the U.S. Army Test and Evaluation Command Instrumentation Development Program, U.S. Army Materiel Command. The feasibility for the concept was developed by the U.S. Army Air Defense Board, demonstrated during 1970, and culminated in a series of live firing tests at Fort Bliss, Tex.

A technical paper on the MIDI Radar, authored by Charles E. French, U.S. Army Air Defense Board, was presented at the 1972 Army Science Conference.

CH-47C, Chinook, hovers with a 9,900-pound cement sling-load and 350 gallons of auxillary fuel, during product-improvement testing (PIT) of the T55-L-11A engine. Simultaneously, 24 other items on this aircraft are undergoing PIT.

APG Develops Paint Remover Considered Nontoxic to Wildlife

A corrosion-inhibited paint-removing composition that is nontoxic to wildlife has been developed by a research chemist at the Coating and Chemical Laboratory (C&CL) at Aberdeen Proving Ground, Md.

Troy R. Nichols, in collaboration with Dr. Myer Rosenfeld, recently retired chief of the C&CL Chemical Cleaning and Corrosion Branch, developed the composition and was recently awarded a patent.

The patent covers an improved alkaline paint remover for use in separating paint from aluminum. It is nontoxic to animals because it contains certain inorganic stannates instead of the commonly used chromates for protecting the aluminum from corrosion. Nichols said stannates permit paint strippers to be formulated for use at higher *pH* ranges and higher efficiencies and are more effective than chromates in preventing corrosion.

He received his BS degree at Tennessee Technological University, majoring in physics and minoring in chemistry. He has done graduate work at Johns Hopkins University and the University of Delaware.

STRATCOM Exceeds Cost Reduction Goal

For the eighth consecutive year, the 8-year-old U.S. Army Strategic Communications Command (STRATCOM) has exceeded its cost reduction goal by saving $13.5 million for Fiscal Year-1972 to top its Army-set quota by more than 35 percent.

STRATCOM-Pacific made the largest contribution to the total with validated economies of $3.5 million, primarily in resource management.

STRATCOM's Safeguard Communications Agency reported savings of $3.2 million; STRATCOM-Europe, $2.3 million; HQ STRATCOM, $1.6 million; Communications Electronics Engineering Installation, $1.5 million; and HQ Fort Huachuca, $1.4 million.

Laser Used to Study Basic Chemical Reactions

Linking the laser with a mass spectrometer to study molecules in their excited states, the National Bureau of Standards (NBS), Department of Commerce, has developed a new tool for studying basic chemical reactions.

A phase-sensitive, molecular-beam-quadrupole mass spectrometer is coupled to a mechanically modulated, continuous-wave gas laser. The method has been used to show that molecules excited by an infrared laser react faster than those in the ground state.

Vibrational excitation of a specific bond in a molecule, using this technique, may enable scientists to produce novel chemical products or allow isotope enrichment. Briefly, the method directs a gas stream at the sampling cone of a mass spectrometer so that the laser beam crosses the gas stream at right angles.

Then a representative gas sample passes through an adjustable orifice into another region that contains a wheel for its mechanical modulation, an ion source for partial conversion of the molecular species into positive ions, and a mass filter and particle detection system.

IN OTHER PROJECTS recently listed the NBS has developed a sulfur dioxide pollution monitoring device in which several manufacturers have already shown an interest.

Based on the measurement of the fluorescence of SO_2 in air, the detector is rapid, continuous, nearly specific to SO_2, and linear in response up to 1,600 parts per million.

About 80 million tons of SO_2 are released into the atmosphere each year, mainly through the burning of sulfur-bearing coal and oil, and through such industrial processes as oil and metal refining. Concentrations as low as a few parts per million can cause breathing difficulty, kill plants, leach limestone, and degrade paper and leather.

The most obvious application of the new device is in monitoring smokestack gases. A recent California law limits the SO_2 concentration in stack gases to 500 ppm, and similar laws are being considered by other states. No present instrumentation measures such concentrations with high reliability.

Another NBS innovation is a spectrophotometer that has achieved new levels of precision and accuracy, and is expected to have a significant impact on spectrophotometry—both as a model for improved instruments and through the improvement of standard calibration filters.

NBS plans to use the spectrophotometer to help realize the candela—the basic unit of luminous intensity or brightness. The design principles developed in this work also should result ultimately in more accurate measurements in clinical laboratories; also, in numerous industries which rely on color measurements—such as paint, textile, appliance and petroleum producers.

Recognizing increasing use of the metric system of measurement in the United States, the Department of Commerce has prepared a plastic metric conversion pocket card which contains the minimum data needed for such conversions.

One side gives the factors for converting from customary to metric units of length, area, volume, mass (weight), and temperature. The other side gives the corresponding conversion factors for going from metric to customary.

Identified as NBS Special Publication 365, the wallet cards cost 10 cents each, and $6.25 per 100. These may be ordered prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or from local U.S. Department of Commerce Field Offices as SD Catalog No. C13.10:365.

Defense Property Disposal Service Formed as New Command Under DSA

Following an exhaustive study to improve the effectiveness and efficiency of disposal programs, the Defense Property Disposal Service (DPDS) has been established as a new command under the Director of the Defense Supply Agency.

Assistant Secretary of Defense (Installations and Logistics) Barry J. Shillito announced formation of the command Sept. 12. It is expected to become full operational by July 1973.

Integrating disposal operations currently performed by the military services and DSA, the DPDS will provide for centralized control, uniform accounting, and standardized organizations and procedures for all defense surplus property disposal activities.

The DPDS will be headed by a military officer of general or flag rank and will be collocated with the Defense Logistics Services Center (DLSC), another major field command of DSA.

DPDS will assume operations which currently encompass 225 installations and more than 7,000 personnel operating in 30 foreign countries and the U.S. It will be responsible for the disposal of surplus personal property with an original acquisition value of $8.5 billion and more than 500,000 tons of scrap annually.

2 Companies Compete on VSTT Development

Air Defense units could be firing at a new training target in FY 1974 when design and development of a turbine-powered Variable-Speed Training Target (VSTT) is expected to be completed.

Its main purpose will be to tow a variety of targets for missile training and evaluation. It will serve as an aerial target for air defense systems such as the Chaparral, Redeye, Hawk and Vulcan.

Scheduled to replace the Firebee MQM-34D target missile for training flights, the VSTT will be capable of flying at altitudes up to 40,000 feet and speeds between 250 and 500 knots.

The VSTT acquisition schedule includes a development program of approximately 30 months to be followed by limited production and, after testing, full-scale production. The development program includes finalizing design, wing tunnel testing, component testing, and system testing during the first 19 months.

The Army signed contracts with Northrop Aviation and Beech Aircraft to produce two competing prototypes which will be demonstrated in late FY 73, after a year of development. Both will then go through engineering tests to determine the degree to which they meet performance requirements.

Following the engineering tests, and correction of any deficiencies, the Army plans to request firm fixed-price proposals for procurement and flight service operations from both contractors in line with predetermined cost reduction objectives.

MICOM Development Improves Rocket Accuracy

Army Missile Command engineers have developed and tested successfully an inexpensive guidance system that functions for less than four seconds but improves accuracy of a large, operational Army rocket.

Flight tested twice on the Honest John system, the guidance package has dramatically improved its accuracy. Additional flights are planned at White Sands (N. Mex.) Missile Range later this year.

An Honest John normally is fired from a launch rail, then follows a ballistic trajectory. Without self-contained guidance, its accuracy can be affected by wind and other factors.

Developed by the Missile Command's Research, Development, Engineering and Missile Systems Laboratory, the guidance system has been packaged to fit around the rocket motor. Thus it does not require removal of the motor or other costly and time-consuming modifications to the rocket. The launcher now being used in tests is the standard device used by tactical Honest John units.

The fluidic control system consists of pressurized nitrogen, a constant gas flow regulator, a fluidic gyro, a modulator and four actuator vanes. The vanes are installed inside the nozzle of the rocket motor and deflect its thrust during system operation to steer the rocket while the motor burns.

Fluidic controls have been under development and testing at the Missile Command for several years. This marks the first application of fluidic controls in a system that could conceivably find use in tactical Army rockets or missile systems.

Design, fabrication and testing of a fluidically controlled Honest John is being accomplished in MICOM's McMorrow Laboratories. Feasibility in prototype flight tests is being demonstrated before proceeding into more advanced development phases.

NBS Develops New Voltage Measurement Technique

Microsecond pulses in the kilovolt range, with promise of application to the megavolt range, are being measured accurately by the use of a new technique developed by the U.S. National Bureau of Standards.

Probeless electro-optical studies of transient electrical stress is based on optical fringe-pattern measurements, similar to those employed in earlier NBS work under high direct voltage conditions.

Credited with the joint development effort are Esther C. Cassidy of the NBS Electricity Division and Stanley R. Booker, Sandia Corp., who have used the technique in HV calibration studies. Use for dynamic electrical stress analysis and for studies of the behavior of liquid dielectrics is anticipated.

Insensitivity to electrical interference suggests that the technique may be uniquely suited to voltage measurements during testing of electrical equipment under simulated lightning impulse or nuclear explosion conditions.

Unlike other methods, the new system is reported by the NBS to eliminate the need for sensitive electrical or electronic detecting devices and recording equipment.

Construction Begins on $102 Million WRAMC Hospital

Walter Reed Army Medical Center, a Washington, D.C., diagnostic, treatment, training and research center rated as one of the world's largest—accommodating Walter Reed Army Institute of Research, the Armed Forces Institute of Pathology and numerous other facilities—is adding a new $102,321,000 hospital.

The present hospital, opened in 1909, will be retained and renovated to serve as an administration building, with the new structure located directly behind and adjoined by a new garage to accommodate 1,100 cars.

Planned to achieve the ultimate in modernization of medical facilities and equipment, the hospital has been designed by Stone, Marraccini and Patterson Architects and Planners, and Milton T. Pflueger, architect, San Francisco, Calif., in a joint venture.

Construction will begin following formal ground-breaking ceremonies Aug. 26, will be accomplished in three phases, and is scheduled for 1976 completion. The firm fixed-price contract has been awarded to Blake Construction Co. and U.S. Industries, Washington, D.C., in a joint venture. The North Atlantic Division of the Army Corps of Engineers is the construction agency.

Demolition of existing structures to make room for the new hospital, and increasing the capacity of heating and air-conditioning plants, is nearing completion. Phase one includes construction of some temporary structures.

The hospital will provide accommodations for 1,280 bed patients and a wide variety of specialty and diagnostic facilities encompassing an area of more than 1,000,000 square feet. Currently, about 16,000 patients annually are admitted and since 1909 more than 500,000 have received treatment. Outpatient visits average 1,000 daily.

Construction of the hospital will be one of the largest building projects in the history of the Walter Reed Medical Center. In September 1962 a massive 5-story wing was added to Walter Reed Army Institute of Research. Since 1967 similarly large wings (north and south) have been added to the Armed Forces Institute of Pathology.

In the new hospital sufficient clearance in interfloor spaces will house all primary mechanical and electrical service systems. This interfloor area is located over each occupied floor and has a walkdeck for easy access for maintenance personnel. An elevator system with five banks of elevators will provide mobility.

Material handling systems include automated dumbwaiters for cars, an automated box system for records and small objects and pneumatic chutes for trash and soiled linen.

Development of the building and site is in accordance with the Master Plan of the WRAMC as approved by the Department of Defense and The National Capital Planning Commission.

R & D NEWS

Army Device Helps Locate Debris-Buried Flood Victims

When locating the bodies of victims buried in the debris of the recent flood disaster in South Dakota proved a problem, use of a U.S. Army ionization detection device designed for on-the-spot analysis of toxic vapors in the air was pressed into service.

Trace contaminants in an open atmosphere or controlled gas stream can be detected and measured with the device, which is 8 inches wide, 8 inches high and 14 inches long. This permitted searches in areas of debris where rubble could not be examined or readily sifted by hand.

The call for Army assistance came to Edgewood (Md.) Arsenal and was referred to the Detection and Alarms Branch, Directorate of Development and Engineering. David W. Robinson, a chemist, and Leo G. Appel, an electronics engineer, were assigned to work with the search and recovery team in Rapid City, S.D.

Sheriff Glen Best of Pennington County said their efforts with the ionization detection device, which does not actually sniff out buried bodies but indicates differences in compositions in the air near them, proved of major assistance.

EDGEWOOD ARSENAL employes Dave Robinson (far right) and Leo Appel (far left) briefed COL John K. Stoner Jr. (second from right), the arsenal's commanding officer, on the mechanical device they employed during search and rescue operations in the South Dakota flood areas. Dr. B. L. Harris (center), technical director, and COL Steven S. Crowell, head of the Directorate of Development Engineering also are pictured.

Electrical Impulse Device May Ease Fear of Dentistry

Fear of the dentist's drill or anesthetic needle may become needless. At least that is the well-founded hope supported by an electric pain-suppressant handpiece that has demonstrated its merit in experimental use.

Clinical use of the device is being studied at the United States Army Institute of Dental Research, Washington, D.C. Introduction of a minute electric impulse into a nerve end immediately prior to dentistry serves to block the transmission of the pain by depolarizing the nerve.

The high-speed handpiece has a miniature electrical generator in the head into which the dentist inserts his drills or grinders (the latter in preparation for capping a tooth with a crown). Aside from the handpiece itself, no additional equipment, electrical connections, or controls are required.

Approximately 1,000 civilian dentists in the United States and Canada reportedly have used the handpiece. Results have shown that the minute electrical impulse produces no detrimental effect on the pulp of the tooth. It is termed "impossible" for the handpiece to generate voltage above the amount necessary for desensitization, about seven-tenths of a volt delivered in the form of "beeps of electricity."

The handpiece provides two benefits for the patient—lack of pain during dentistry and elimination of the need for painful injections, with their residual effect. The dentist benefits in the time-saving factor of the method since he does not have to wait for the patient's tooth to become numb.

Improved Communication Center Put Into Operation at WSMR

An improved communication center, planned since 1967, was recently put into operation at White Sands Missile Range, N. Mex., in the third phase of scheduled improvements for its outlying complexes.

Located at the WSMR Small Missile Range (SMR), the new facility required eight months of preparation, including the move of a microwave tower some 300 yards from the old center to the new site. Serving an area about 10 miles from the main post, the new center provides twice as many lines on the SMR net.

"The biggest advantage to us," explained one official, "is that we'll have communications mission control, the central office for telephone exchange and the timing station under one roof, instead of having them scattered in the area."

The center will allow for an extensive intercom system at the SMR and will automatically level signals throughout the net. Timing circuitry relates each element to the range's official time system.

USAARL Studies Problems of Long-Range Troop Deployment

By Dr. Edward J. Baldes (See p. 35) and LTC Stanley C. Knapp Jr.

Recommendations based on studies in three exercises have been made by the U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Ala., to reduce the aeromedical problems in long-distance deployment of troops.

USAARL's mission includes the aeromedical aspects of long-range, large-scale aerial troop deployment. Recently, several observations have been made during major deployment exercises regarding problems in the proper accommodations for troops while traveling to insure that soldiers arrive at their destination in good condition.

In Reforger I, a joint U.S. Army/U.S. Air Force/North Atlantic Treaty Organization (NATO) exercise, the deployment was eastward in C-141 Starlifter aircraft for more than 5,000 miles through seven time zones. The purpose of the research done during this exercise was to study the factors contributing to biologic cycle disturbance, known as circadian dysynchrony, and other aeromedical problems of troop deployment.

Conversely, the travel was westward in the joint Southeast Asia Treaty Organization-U.S. Readiness Command exercises Focus Retina and Freedom Vault. The purpose was to identify specific medical problems occurring during the deployment operation, as observed by USAARL aviation medicine experts.

Eleven time zones were spanned during exercises Focus Retina and Freedom Vault, using aircraft equipped with non-reclining seats. Troops were fully equipped with all personal gear and individual rations. Rest stops were short and infrequent. Meals were irregular and incomplete. Arrival at the destination was followed by a parachute assault and 72-hour maneuver.

Common to all three exercises, but more severe in Focus Retina and Freedom Vault, was the inability of the troops to secure adequate sleep and rest. This was caused in part and/or aggravated by uncomfortable seats, crowded conditions, burden of personal equipment and rations, high noise levels, inadequate mess facilities and other problems.

As a result of these stresses, soldiers experienced significant fatigue and malaise, with a considerable decrease in physical and mental ability as well as in endurance. Troop commanders found decisions more difficult and troops less motivated as a fighting force.

RESTFUL SLEEP was impossible in the high-density seating configuration formerly used in long-distance deployment of troops. High noise levels contributed to sleep loss and prevented effective communications between crew and troops. Congested conditions in a typical troop deployment aircraft are shown in accidental decompression drill.

The medical officer in such a situation faces a plethora of minor complaints and symptoms—of which the etiology remains obscure unless he understands the precise nature of stresses the soldiers have experienced.

In civilian air transport operations, usually no effort is spared to insure that the passenger is kept as comfortable, relaxed, well-fed and well-rested as possible. Quite appropriately, similar effort has been directed to keep civilian and military aircraft crews operating at peak efficiency, and to insure all possible safety precautions.

Military passengers, and in particular combat-equipped soldiers on an operational deployment, have not generally fared as well. Operational necessity and an inadequate appreciation for the limitations of men have resulted in putting more people into less space and less comfortable accommodations than in civilian aircraft.

Designers and engineers of military aircraft have failed to recognize the limitations of the individual soldier, and to assess him as a human being instead of a piece of cargo.

(Continued on page 27)

Biographical information on Dr. Baldes is featured on page 35, "People in Perspective."

Since 1968 LTC Knapp has been The Surgeon General's representative on "Long-Range Troop Deployments." He has also been a consultant in aviation medicine to NATO and a member of several committees concerned with aerospace medical problems. Currently he is assigned as director of the Bioengineering and Evaluation Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, Ala.

During 1967–69 he was a resident in aerospace medicine at the U.S. Air Force School of Aerospace Medicine, Brooks Air Force Base, Tex. He also attended the U.S. Army Aviation School, Fort Rucker, Ala., in 1966.

He has a 1958 BA degree in zoology and metallurgical chemistry from Andrews University, a 1962 MD from Loma Linda University, Los Angeles, Calif., and a 1967 master's degree in public health administration from the University of California at Los Angeles. He has also done postgraduate work at the University of Southern California and the University of Arizona.

LTC Knapp served in 1966 as aviation medical officer, Lyster Army Hospital, Fort Rucker, Ala., and as assistant chief, Aviation Medicine Clinic. During 1964–65 he was battalion surgeon, 3d Battalion, 508th Infantry, Fort Kobbe, Canal Zone, and in 1963–64 battle group surgeon, with the 82d Airborne Division, Fort Bragg, N.C.

Army's New Precise Explosives Technology Blasts Part of Flood-Damaged Dam to Divert Water Safely

CUT ALONG DOTTED LINE tells the story as U.S. Army Corps of Engineers personnel from the Explosive Excavation Research Laboratory prepare explosives (top and center) for detonation along a section of the Fort Meade Dam to ease the pressure that might have collapsed it, by rerouting flood waters that threatened the nearby town of Sturgis during the South Dakota floods. Photo at lower left shows the clean cut produced by sequential detonation of the explosives, which safely rerouted the flow of water.

By LTC Robert R. Mills Jr.

How could advanced engineering technology save a town threatened imminently by catastrophic collapse of a dam under pressure of rampaging waters in the recent disastrous South Dakota floods?

That question was answered with dramatic success by U.S. Army Corps of Engineers personnel from the Explosive Excavation Research Laboratory, based at the Lawrence Livermore (Calif.) Laboratory. Their action tremendously relieved residents of the town of Sturgis (population approximately 6,000) about two miles from the dam and 30 miles northwest of Rapid City.

How did they do it? The technique they used was depicted on the front cover and given feature story treatment in the July edition of the *Army Research and Development Newsmagazine.*

"Instant excavation" described the precisely controlled and timed (in microseconds) sequential detonation of nuclear or conventional explosives, as accomplished by more than 10 years of Army research and development effort.

But how can such technology save a dam threatened by the demolishing impact of flood waters? The answer: By removing a precisely determined portion of the dam, already weakened by the floods, thereby permitting a safe amount of water to pass through and thus re-

lieving pressure on the rest of the dam.

During heavy rains in early June, a torrent of water had spilled over the crest of Fort Meade Dam, washing away much of the rock fill that supported its concrete face. An Army engineer at the dam reported that 7,000,000 gallons of water were still trapped and straining against the damaged structure. He predicted that if the dam failed, "a 10-foot wave of water would hit Sturgis within 15 minutes."

Two other dams in the Rapid City area—Deerfield and Lake Park—had already given way under similar conditions. Army engineers were trying to prevent a third such failure. Their task was twofold: pump out and reroute as much of the trapped water as possible; remove part of the dam so future flood waters would cease to threaten Sturgis with catastrophic failure of the dam.

Breaching the dam with conventional equipment, it was estimated, would take about a month. Knowing the job had to be done within a few days, the Army engineers put in a call June 15 for help to the EERL office in Livermore.

The next morning Dick Fraser and Bruce Redpath, EERL civilian engineers, were on their way to Rapid City. MAJ Joe Briggs, returning to Livermore from Fort Peck, Montana, received revised orders and he, too, headed for Rapid City. Civilian engineer Charlie Snell joined them later.

While the Livermore team was en route, Army National Guard engineers went to work relieving some of the stress on the dam. They used four large pumps to lower the water level of the lake 12 feet below the dam's crest. They also enlarged the spillway from the dam, which had proven inadequate.

When the Livermore team arrived they saw a dam of rock, masonry and reinforced concrete, 56-feet high and 215-feet long. Asked to blast a large hole in the dam to let the water through, they pointed out that a hole would eventually clog with debris and cause a future problem. Instead, it was decided to remove completely an 80-foot-long by 25-foot-deep section on one side.

"The demolition plan we devised called for us to outline the portion of the dam to be removed with a line of closely spaced drill holes loaded with dynamite," MAJ Briggs explained. "We would break up the reinforced concrete with seven 150-pound charges placed on the surface of the dam, and would eject the broken concrete with a 1,700-pound charge placed in a cavity near the dam's base. We figured it would take us three days to get ready."

Creating the cavity for the main charge was started on Father's Day, June 18. Heavy rains halted work on Monday, but Tuesday morning some 20 National Guardsmen started to drill the dynamite holes.

"The men worked slowly at first," recalled Bruce Redpath. "They were volunteers from an Artillery unit and they had no experience using air-powered rock drills. But they learned remarkably fast and by day's end all 89 holes had been bored into the reinforced concrete."

When the drill work was completed, the cavity for the main charge was enlarged to its final size—six feet deep and 11 feet wide.

Good weather continued Wednesday and the men set about preparing the explosives. But they ran into another delay. The 2,000 pounds of TNT shipped to the site came packed in ¼-pound cans—8,000 of them!

Half the cans had to be repackaged into sandbags and loaded into the cavity along with 700 pounds of dynamite. The rest of the cans were left in their wooden boxes and were placed on both sides of the dam. Then, about 225 pounds of dynamite was put into the 2-inch wide, 4-foot deep holes that perforated the dam wall. Finally, 500 bags of sand had to be filled and hauled to the dam to close off the cavity.

By late Wednesday night, only a day off schedule because of the rain, all was ready. The last operation, attaching a blasting cap to the detonating cord, was left until morning.

The weather Thursday was warm and clear. Blast time had been set for noon. Shortly before noon, the Livermore team stationed itself about a half-mile upstream and waited. For several days the din of pumps, air drills, small explosives and construction equipment had filled the air. Now all was quiet.

At 12 o'clock sharp all charges were detonated simultaneously. Dust, rock and debris rose in a cloud and a 200-foot fireball enveloped the dam. The Livermore crew waited anxiously.

Within about three minutes the dust settled and the men knew they had done their job. The dam wall had broken cleanly along the perforated line. Water began flowing through the hole and safely on its way past Sturgis.

In summing up the operation, MAJ Joe Briggs said: "This rush effort on the part of EERL highlights some of the advantages of explosive excavation. In four days, at a cost of about $10,000, we accomplished what would have required a month and perhaps as much as $150,000 if attempted with conventional construction equipment."

The author, LTC Robert R. Mills Jr., is the new director of the U.S. Army Explosive Excavation Research Laboratory (EERL). He succeeds LTC Robert L. LaFrenz, who has returned to the U.S. Military Academy (USMA) at West Point, N.Y., as an associate professor in the Physics Department.

LTC Mills is a graduate of the University of Wisconsin and received an MS degree in nuclear engineering in 1964 from North Carolina State University, where he will receive a PhD this year. He recently graduated from the U.S. Army Command and General Staff College, Fort Leavenworth, Kans.

In addition to a USMA assignment as assistant professor of physics, he has had overseas tours to include Thailand, Germany and Vietnam.

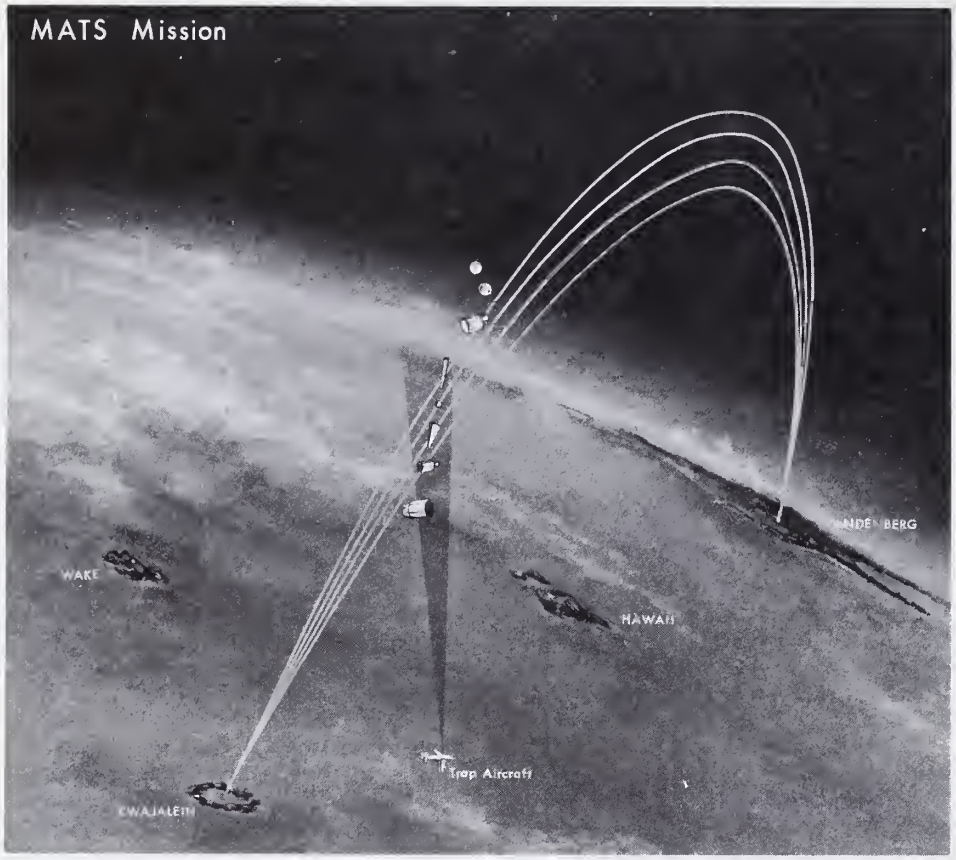


Fig. 1. Typical MATS test mission launched from Vandenburg AFB. A target complex is acquired, tracked and optically analyzed by the airborne infrared sensor system.

ABMDA Developing . . .

Airborne Infrared System of 'Fingerprinting' Targets

By Boyd C. Wooten Jr.

An airborne long-wavelength infrared sensor system capable of making radiometric measurements of reentry bodies during late mid-course and early reentry is being developed by the U.S. Army Advanced Ballistic Missile Defense Agency (ABMDA).

Designated Midcourse Airborne Target Signatures (MATS) system, it will measure and record, in discrete optical wavelength regions, the "fingerprint" or "signature" characteristics of a variety of targets.

A typical test target complex, shown in Figure 1, consists of a combination of decoys, chaff clouds, booster, and reentry vehicle, all of which will be measured by the MATS system, operating from a high-altitude aircraft.

By measuring the "brightness" in two different infrared "color" bands, one can compute the temperature and the effective emissivity of an object, which is an indication of the size of the object. Changes in "brightness" with time yield the temperature history of the object during the late mid-course and early reentry portion of the trajectory.

Since the decoys, chaff clouds, booster and reentry vehicle have different sizes, temperatures and temperature histories, they will produce different "signatures." Measuring and cataloging the signatures of known objects will permit rapid identification of future unknown objects in flight.

To accomplish the measurements function, the MATS system must acquire the target complex before it approaches within 100 nautical miles in range and 500,000 feet in altitude, and it must track the target until it reaches an altitude of 100,000 feet. The goal of probability of successful acquisition has been set at 95 percent.

The MATS system consists of a telescope, mounted on a gimbal located within a special canopy on top of a KC-135 aircraft fuselage, and electronic controls and displays located in the aft section, as pictorially represented in Figure 2. The major electronics are the Acquisition and Pointing Subsystem and the Control and Processing Subsystem. Each of these subsystems is controlled by an operator stationed at the master control console.

The MATS telescope, shown in Figure 3, is a 15-inch aperture, f/2.2 modified, fold-Gregorian system with a one-degree field-of-view and an optical resolution of 0.3 milliradian. The telescope parameters were largely set by the physical limitations of the available aircraft space.

Beryllium is used for the reflecting optical elements. A dual-channel, 48-element array of detectors, covering the total spectral region of interest, is mounted in the focal plane area of the telescope. The array subtends a one-degree elevation angle and scans in azimuth by moving the telescope in that direction.

The detectors operate at low temperatures, necessitating complex and extensive cooling subsystems of extremely high stability.

The optical system is well-baffled throughout to reduce the intensity on the detectors from out-of-field radiation sources and scattered radiation from the various mirror surfaces. A special optical

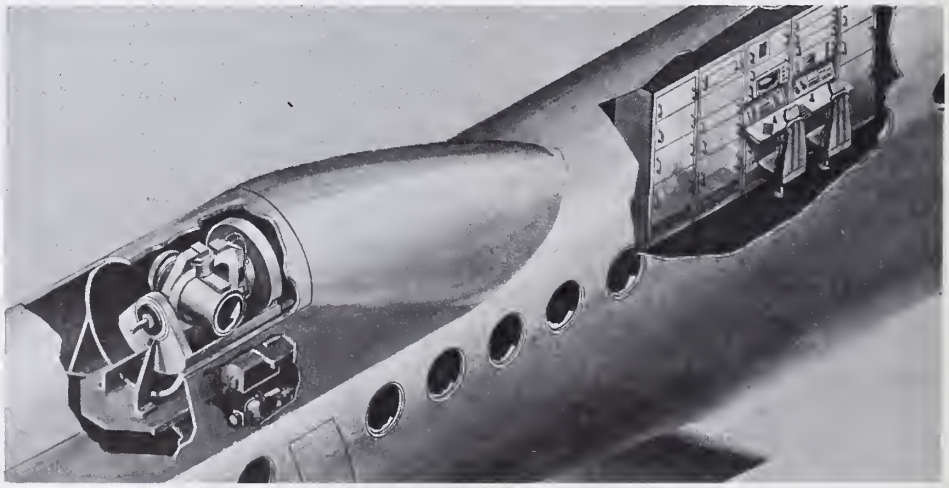


Fig. 2. MATS Sensor and Controls in KC-135 Aircraft.

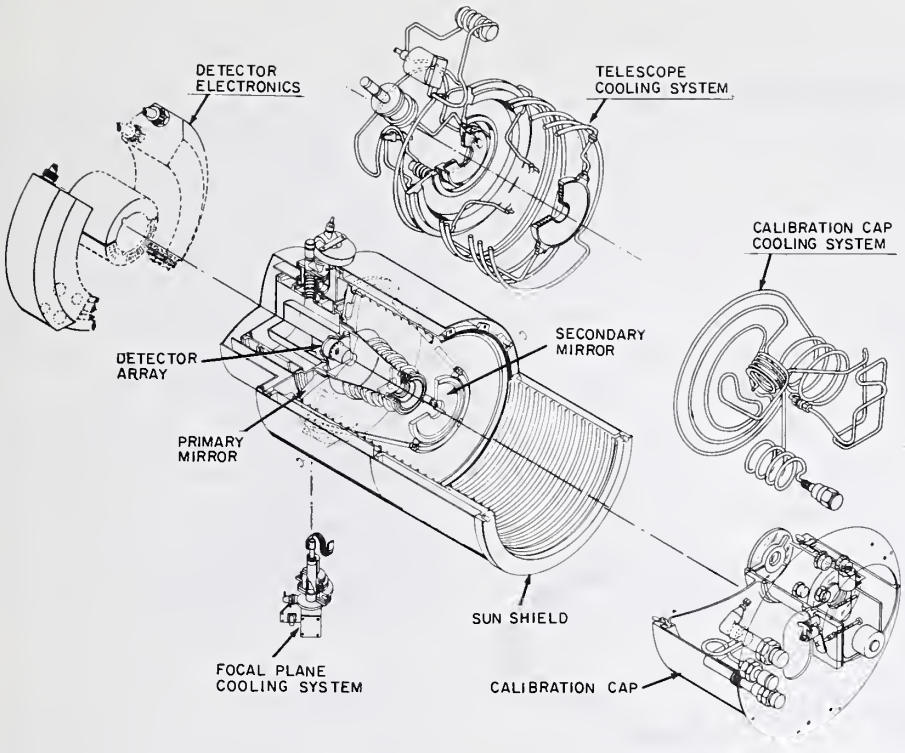


Fig. 3. MATS Telescope

ray-trace computer program was developed to evaluate the effectiveness of the baffle structures.

A calibration cap, driven into position over the telescope entrance aperture when the telescope is stowed, has a scanned, collimated light source that, when used in conjunction with a blackbody source within the telescope body, provides radiometric calibration for the system.

A servo-controlled gimbal subsystem supports, aligns and points the telescope in azimuth and elevation upon receiving angular rate commands from the Acquisition and Pointing Subsystem.

In the absence of any angular rate commands, the gimbal stabilizes the telescope pointing with respect to inertial space. The aircraft canopy drum is slaved to the gimbal elevation axis to keep the canopy window centered around the telescope aperture.

The radiometric signal output of the telescope/detector array is match-filtered for real-time acquisition, using the computer and display, and is also wide-band recorded for post-mission data processing and interpretation.

Lift-off time and inter-range target vector (IRV) data are fed to the MATS aircraft by range stations during a measurements mission. To accomplish acquisition, trajectory data must be computed on-board in real-time. The real-time computations include target position and aircraft position, which are combined to provide pointing information for the telescope.

The aircraft position is obtained from an Attitude Reference System (ARS), which consists of an inertial platform with its own digital computer, augmented by a TACAN radio navigation updating subsystem to correct errors caused by drift in the inertial system.

The solution to the problem of reliable acquisition is complex. Significant contributions to the complexity are: time available to acquire the target is short; both aircraft and target location accuracy requirements are high; and the sensor field-of-view is relatively small.

Geometry involved in the solution is illustrated in Figure 4. The missile, launched at the upper right-hand side of the diagram, produces the target trajectory shown.

Because of some uncertainty in aircraft and target locations, a search scan must be employed by the sensor to acquire the target. However, scanning is only required in the azimuth direction, since a time scan is automatically generated by the passage of the target across the acquisition "window."

A typical window, or search field-of-view, is one degree in elevation (determined by the detector geometry) by three degrees in azimuth. Under worst-case conditions, target transit-time across the window is only one second. During the average mission, it may be only several seconds at best.

The probability of the target passing through the window is determined by the pointing accuracy of the system. The probability of acquisition is a function of the azimuth scan velocity of the telescope.

The MATS system will scan rapidly enough to guarantee two scans across the target as the target passes through the window. To provide a measure of safety in case the target is not immediately acquired, the acquisition window may be "leap-frogged" to locations farther down range.

A mission timeline for acquisition and tracking is shown in Figure 5. Launch time is relayed to the aircraft approximately 30 minutes before impact. Aircraft position is updated using the TACAN system about 5 minutes later. The operator may then vary certain parameters, such as acquisition slant range.

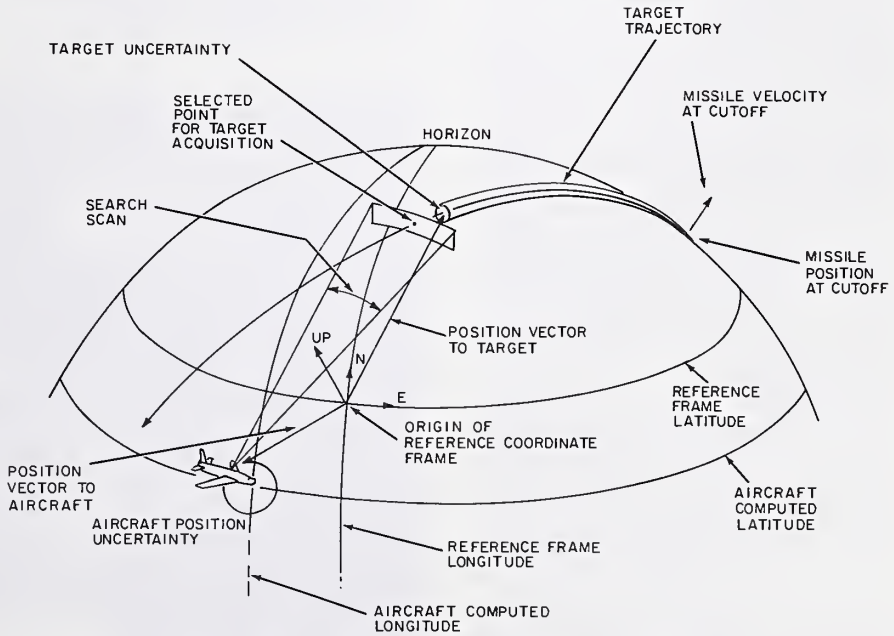


Fig. 4. Acquisition Geometry.

ABMDA Developing . . .

Airborne Infrared System of 'Fingerprinting' Targets

(Continued from page 21)

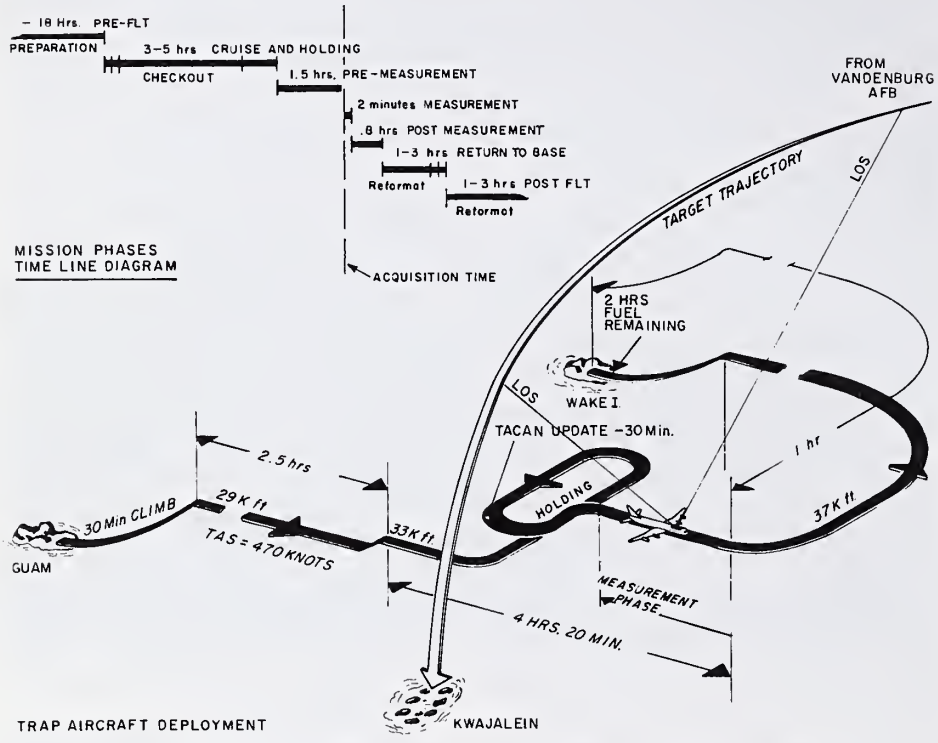


Fig. 5. Typical Mission Timeline for Acquisition and Track Mode.

Target trajectory data are relayed to the aircraft approximately 20 minutes before impact. These data are used to compute exact target position. A final acquisition point is then calculated based on slant range, aircraft position, and computed target position.

The MATS system then sets the scan amplitude and velocities, computes and displays error ellipse parameters, and calculates and displays the predicted signal-to-noise ratio at acquisition.

Approximately five minutes before acquisition, the telescope is uncapped and driven to the nominal acquisition point. The telescope is commanded to point at this nominal acquisition point as the aircraft flies toward its acquisition station. Current aircraft position is continually fed into the system by the ARS computer.

As the target enters the acquisition region, it is scanned and the data recorded on displays. The operator locates the target on the acquisition display, using a cursor and stiff stick. This action provides information to the system that enables it to initiate target tracking.

In the track mode, the telescope will follow the target down to the 100,000-foot level, with the track operator providing stiff stick corrections to insure that the target does not drift off the track display. Figure 6 shows the acquisition (left) and track (right) display/control sections of the master console.

CONTROL AND PROCESSING. A Central Processing Computer is the heart of the control and display system, interfacing with all subsystems, the operators, and the aircraft crew, and generating commands and accepting data to acquire and track a target.

Acquisition and track operators are an integral part of the command loop, providing over-all control and exercising judgment during critical points in the mission. Figure 7 (page 23) is a block diagram showing the over-all MATS system control/processing logic.

Radiometric data obtained by the MATS system is fed into a data recorder and a data processor. Both radiometric and calibration data from each detector in the telescope are recorded, as is system data required for mission analysis and diagnostic evaluation. The processor reformats the recorded data to provide output in IBM-compatible tapes.

The system also controls and monitors the temperature of the telescope and records precision time reference signals with the radiometric and mission data for data reduction and mission analysis purposes.

When MATS system design and fabrication are completed late this fall, the responsibility for final calibration and integration into the aircraft will be passed from the Army to the Air Force, which will operate the system in the flight test programs expected to extend over several years. The data generated will be used in both Air Force and Army weapon system developments.

The Perkin Elmer Corp. of Norwalk, Conn., is prime contractor for the MATS system. The measurements flight program is a joint Army/Air Force effort. The aircraft modifications are being accomplished by the Air Force through E Systems, Greenville, Tex.

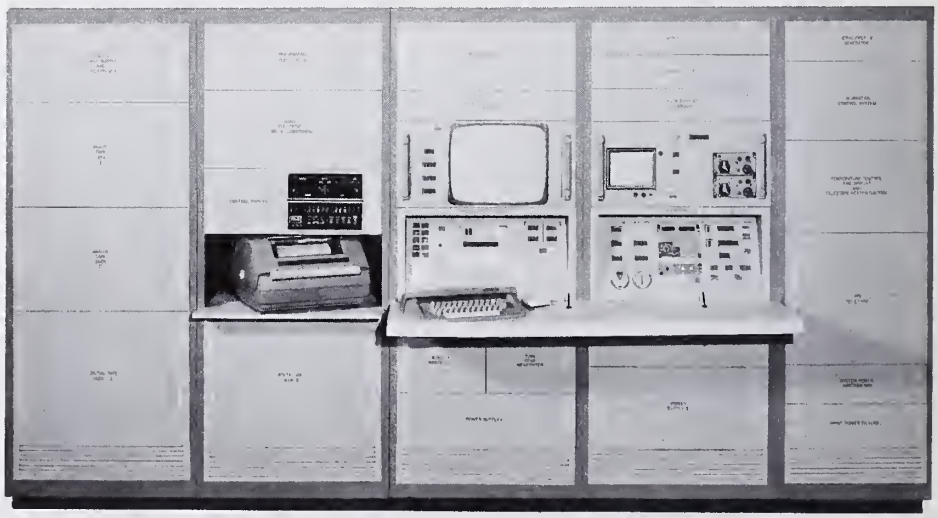


Fig. 6. MATS Control and Display Console.

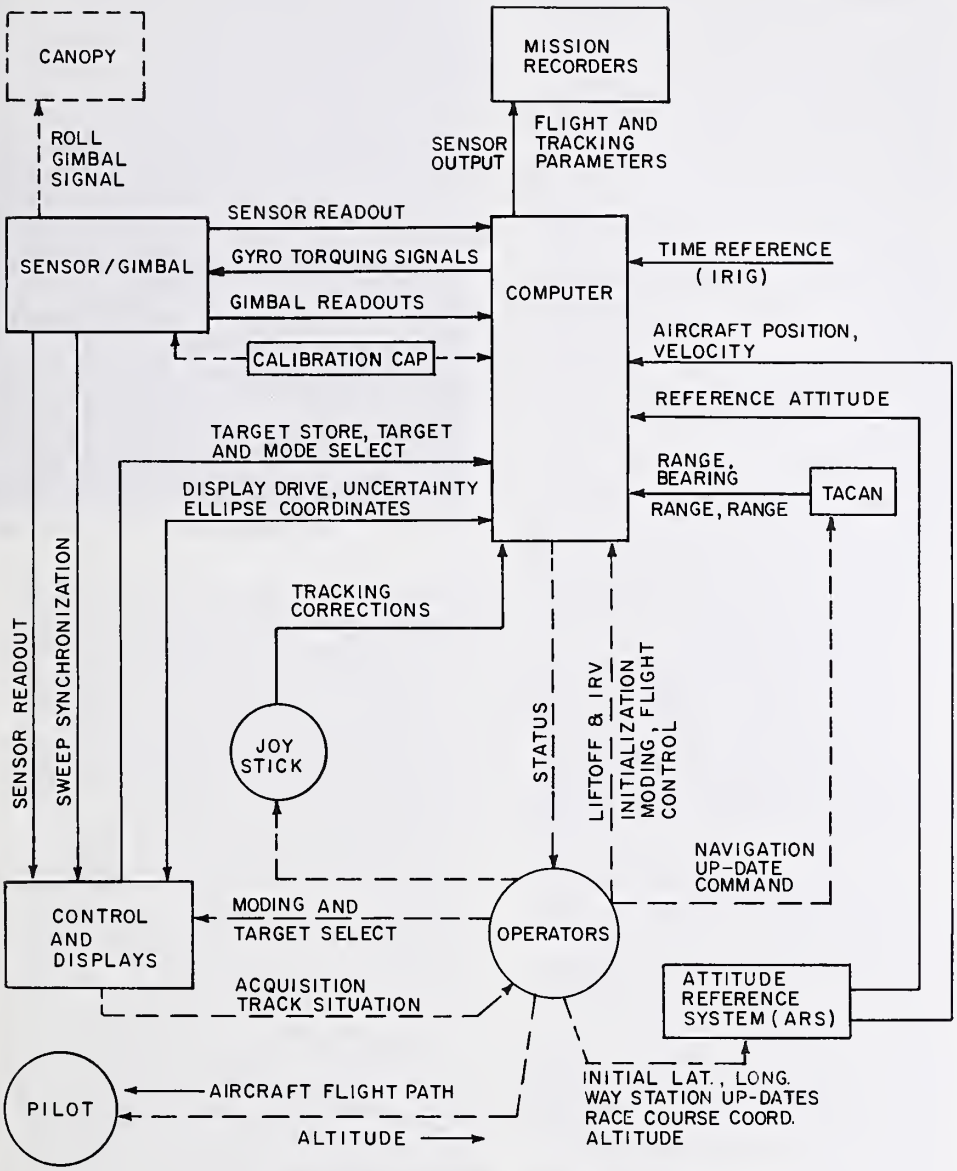


Fig. 7. MATS System Block Diagram.

BOYD C. WOOTON Jr. is a physical scientist in the Optical Group, Area Defense Program Office, U.S. Army Advanced Ballistic Missile Defense Agency (ABMDA) in Arlington, Va. Wooton received a BS degree in physics and mathematics from Western Kentucky University in 1956 and has completed graduate courses in nuclear physics, electromagnetic radiation and optics.

He was employed for six years by Sperry Rand Corp. in Gainsville, Fla., where he was responsible for development and production of miniature reflex klystrons and traveling wave tubes. Later he was employed by the U.S. Army at the Nike-X Project office in Huntsville, Ala., where he was responsible for light gas gun experiments and various optics programs.

In 1968, he established the U.S. Army Advanced Ballistic Missile Defense Agency's Optics Group in Huntsville and joined the Washington office in 1969. One of his primary responsibilities has been management of the Airborne Optical Measurement Program.

TECOM Considers Factors Of Light Affecting Testing

Representatives from 18 Army activities recently attended a meeting on light factors affecting testing sponsored by the U.S. Army Test and Evaluation Command, Yuma Proving Ground, Ariz.

A number of papers were presented and discussions held on measuring illumination at night and the illumination needs of the soldier. Attendees also talked about the problems in measuring light reflected from snow in the Arctic.

Several Munitions Command (MUCOM) representatives talked about flare system requirements and new concepts in pyrotechnics. Electronics Command (ECOM) personnel left the visual spectrum to discuss infrared measurements and similar problems in requirement definition.

Presentations by the Army Materiel Systems Analysis Agency and the Ballistic Research Laboratory covered developments in using computer models. Models also were used to predict the best time to conduct vision tests.

As a result of the meeting, groundwork was laid for further cooperative effort in a major problem area, and the exchange of information benefited many current studies.

Personnel at CRREL Win Special Awards

Three members of the U.S. Army Cold Regions Research and Engineering Laboratory (USACRREL) staff were recently presented awards by the U.S. National Committee on Rock Mechanics, National Research Council, National Academy of Sciences.

CPT Randolph J. Martin III received the annual research award for his paper, "Time-Dependent Crack Growth in Quartz and Its Application to the Creep of Rocks."

A special award for outstanding contributions to rock mechanics was given to Dr. Ivor Hawkes and Dr. Malcolm Mellor of USACRREL for their papers, "Uniaxial Testing in Rock Mechanics Laboratory" and "Measurement of Tensile Strength by Diametral Compression of Discs and Annuli."

CPT Martin, a lecturer at Boston College before he entered military service, received his doctorate in geology from Massachusetts Institute of Technology in 1971.

Dr. Mellor received a doctorate in structural engineering from the University of Sheffield, England, in 1970 and has been employed by USACRREL since 1971. Dr. Hawkes also has a doctorate from Sheffield University and is serving as a consultant research engineer on the USACRREL staff.

'Invisibile Dye' Identifies Thefts

Color it "caught" for those who attempt to pilfer gasoline and related petroleum products from U.S. Army storage sources or vehicles in the future—with detection accomplished by an identifying color additive.

The U.S. Army Land Warfare Laboratory at Aberdeen (Md.) Proving Ground reports development of the new method of discouraging gasoline thieves.

The additive is an "invisible dye," a chemical so potent that one gallon can "dye" 20,000 gallons of gasoline. Actually the dye comes in six different colors which show only with the aid of an identification kit. In this way, the specific storage area from which the gasoline or related fuels was stolen can be ascertained.

Army Atmospheric Sciences RDT&E Program

By Dr. Fernand P. de Percin

History provides vivid accounts of battles lost or won because of the weather, and the lessons learned are no less valid today. Weather remains a critically decisive tactical-operations factor of the highest order of importance. It may not be the paramount factor, to be sure, but knowledge of the *current* and future weather is indispensable to the planning and conduct of combat operations.

General Maxwell D. Taylor, referring to the Korean War in his recent book, "Swords and Plowshares," states: "A central theme was the importance of learning to use our military resources effectively in a limited war. . . . In combination, the enemy, the terrain and the weather tended to nullify the usefulness of much of the costly equipment procured during and after World War II in preparation for another world war, presumably to be fought primarily in Western Europe."

Army activities affected by the atmosphere are: surveillance, target acquisition, night observation (STANO); weapon systems; mobility; communications; planning and logistics; mapping and geodesy; environmental protection, pollution abatement; research, development, test and evaluation; tactical and strategic plans.

As Army weapons systems and materiel become more sophisticated, the need for defining Army meteorological requirements early in the development cycle becomes more urgent. This is especially true if the Army is to obtain an ultimate goal of an "all-weather operational capability."

The lack of an expression of these requirements often results in the discovery, late in the development cycle or after fielding of equipment, that the equipment will not function under adverse weather conditions.

Early identification of possible meteorological sensitivities will permit parallel development of the necessary meteorological supporting systems or meteorological techniques which can provide corrections for the effects of the atmosphere.

Air Force and National Weather Service global weather systems provide broad-scale weather analysis and forecast information for the Army. However, unique Army needs, especially the capability of providing detailed and accurate information of local weather conditions on a realtime basis, frequently called NOWCASTS, are recognized.

Few Army personnel seem aware that the Army has the responsibility to fulfill its own requirements, not only for research, development, testing and evaluation (RDT&E) but for specialized meteorological support in the field army. Under the terms of the joint AR 115-10/AFR 105-3, the Army is required to fulfill its own requirements for the following meteorological support:

- Meteorological observations required for direct support of Army weapons systems, including upper air soundings for artillery fire support, and target location; on-site meteorological observations for chemical and nuclear operations; and provision of other special meteorological data that can be more efficiently provided by an Army observing capability.
- Meteorological observations forward of division headquarters elements.
- Specialized support to Army RDT&E activities.
- Soil trafficability and river-stage and flood forecasts.
- Other special support the Army can provide more efficiently or economically as determined by mutual agreement.

Operational responsibility for meteorological support, as indicated, applies throughout the field army structure, especially forward of division headquarters. This is precisely where the Army's tactical—both air-mobile and ground—operations take place, where nuclear and chemical activities have the greatest immediate tactical significance and where the Army's weapons systems are employed.

Within the field army, however, the operational responsibility for this tactical meteorological support is fragmented. There exists a definite requirement for the Army to have a single agency responsible for the Army's operational requirements in the field.

Such a proponent would: (1) be the focal point for tactical operational meteorology; (2) survey and coordinate the field army's meteorological requirements and operations; and (3) assist in the development and presentation of an integrated meteorological program for the field army.

To assure the continued flow of fundamental knowledge and provide the meteorological techniques and equipment required by the field army to carry out its responsibilities, the Army conducts an extensive RDT&E program in the atmospheric sciences.

Carried out under the direction and guidance of the Office of the Chief of Research and Development, this program involves approximately 900 people at four laboratories of the U.S. Army Material Command, and an annual budget averaging about $13 million.

The largest of these laboratories, by far, is the U.S. Army Electronics Command's Atmospheric Sciences Laboratory, White Sands (N. Mex.) Missile Range. A part of this laboratory is located at Fort Monmouth, N.J.

Similarly important atmospheric sciences laboratories are located at Deseret (Utah) Test Center, an element of the Test and Evaluation Command (TECOM), the Ballistic Research Laboratories at Aberdeen (Md.) R&D Center, and at Redstone (Ala.) Arsenal, Missile Command (MICOM) headquarters.

The RDT&E programs conducted at these laboratories fall under the four broad categories: atmospheric sensing; atmospheric prediction; atmospheric modification; and atmospheric effects on weapons and operations.

Atmospheric Sensing. Present atmospheric sensing and probing techniques are inadequate for Army purposes. Army operations require more precise and more accurate atmospheric descriptions than are available from conventional sources.

Fortunately, recent developments in weather radar, laser and acoustic technology, and the use of rockets and meteorological satellites have expanded the capability for surveillance of both lower and upper atmospheric conditions. This is particulary evident in the recent advances in meteorological satellites.

Beginning in fiscal year 1973, the Army will initiate a major program to obtain and analyze data from existing and planned meteorological satellites of other U.S. Government agencies. The goal is to develop techniques for using meteorological satellite data to support field army tactical operations.

Other remote-sensing research studies will concentrate on the use of lasers, lidar (optical radar), and the millimeter wave radiometer. The objective is to develop necessary equipment and techniques for obtaining atmospheric information and data significant to Army weapons systems and operations.

Special emphasis is being placed on remote sensing of the atmosphere to provide timely and accurate data, and also to permit the acquisition of data from remote or inaccessible areas.

Sensing is not confined to the lowest levels of the atmosphere. Important research studies are being conducted to increase our knowledge of the D and E regions of the ionosphere, beginning about 60 to 100 kilometers above the earth's surface.

With improvement of *in situ* sensors, measurements are being made of electron density, minor constituents, positive and negative ions, water vapor, ozone and oxides of nitrogen.

These studies will give a better understanding of ionospheric conditions and changes in-

HELICOPTER DOWNWASH dissip

THE AUTHOR Acknowledges

The author acknowledges the use of material including publications, reports and illustrations prepared by the following laboratories: U.S. Army Atmospheric Sciences Laboratory, ECOM, WSMR; Meteorology Division, Deseret Test Center, TECOM; Aerophysics Branch, Physical Sciences Directorate, Redstone Arsenal, MICOM; Aeronomy Branch, Signature and Propagation Laboratory, Ballistic Research Laboratories, Aberdeen, Md.; and Army Cold Regions Research and Engineering Laboratory, Hanover, N.H.

of fog and clouds over an airfield.

duced by natural (solar flares) and man-made (nuclear) disturbances. This research is significant for weapons and communications systems which operate in or through the ionosphere.

Recent accomplishments in the Army remote-sensing research include:

- Potential use of the Erbium-YAG laser to detect methane in the atmosphere released in the exaust gases by camouflaged or concealed vehicles.
- Attenuation of laser energy in the "atmospheric window" of the electromagnetic spectrum by dust.
- Studies of significant distortion effects on laser energy by atmospheric turbulence.
- Field use of a ground-based millimeter wave radiometer (a passive device) to measure temperature profiles to 10 km aloft.
- Development of a low-level wind cross-beam technique which may provide a capability for obtaining wind measurements needed for direct fire weapon systems, such as the tank.

Newly developed sensors and instruments will further expand Army capabilities in support of the Army in the field. These include:

- Portable Weather Observing Pack for measuring surface weather conditions at forward bases.
- The air-dropable Portable Automatic Weather Observing Station to measure surface weather conditions in remote or inaccessible areas.
- Mobile Weather Radar for measuring nuclear and natural clouds and precipitation out to a range of 240 kilometers (150 miles) and a height of 50 kilometers.
- Meteorological Data Sounding System for measuring wind, temperature and humidity to 30 kilometers aloft.

Atmospheric Prediction. The prediction of weather conditions which critically affect virtually every facet of military operations is of primary concern to the Army. Until atmospheric conditions can be modified or controlled, it is essential that they be predicted as accurately, and in as timely a manner, as modern technology will permit.

Mesometeorology, involving small-scale local weather conditions, is of particular interest to the Army and requires increased emphasis. Small-scale weather phenomena (e.g., fog, thunderstorms, squalls) are exceptionally difficult to predict. Yet these are the very conditions that cause destruction and operational problems throughout the battlefield.

To improve the capability to observe and predict these small-scale weather conditions, the Army has embarked on the development of the Automatic Meteorological System (AMS). The AMS is visualized as an integrated tactical meteorological system for field army use by 1985.

This system embraces automatic observations, analysis, computation of application data, dissemination and display of atmospheric information in the scale, detail and format, accuracy and timeliness required by each supported Army operational element on a scheduled and/or demand basis. The AMS will acquire data from all possible sources—standard weather observing stations, special remote sensors, and meteorological satellites.

The first-generation AMS, to support artillery, is scheduled for completion in fiscal year 1975, utilizing newly developed software techniques and existing "off-the-shelf" equipment.

The second-generation AMS 1985 will use newer and more sophisticated techniques and equipment, especially meteorological satellites. It will support four operations: (1) artillery; (2) chemical; (3) air operations; and (4) ground mobility.

Recent developments of physical and numerical models of atmospheric processes and systems, and the introduction of objective methods, also have produced significant improvements in predicting atmospheric conditions.

Furthur development of these prediction techniques for the Army's special needs will concentrate on exploiting and developing digital computer analyses, and modeling techniques that include local atmosphere-terrain relationships.

In a continuing effort to increase our capability to predict the trajectory, transport, diffusion and concentration of aerosols, Army atmospheric scientists have conducted over 500 field experiments. Research has been conducted in varied terrain (forest, jungle, urban, coastal, desert and mountain-valley) under all types of meteorological conditions.

Fluorescent particle (FP) tracer techniques developed for these field tests have become the standard technique in many of today's environmental studies. Knowledge gained from this research is of vital interest to the Army and has application to offensive and defensive use of chemicals, defense against biological attack, and protection against toxic rocket fuel effluents and nuclear fallout.

Techniques developed from this research were successfully employed during Operations CHASE and REDHAT. Operation CHASE involved the movement by train of toxic material through populated areas to a seaport. Operation REDHAT involved the safe movement to Johnston Island in the Pacific of over 13,000 tons of toxic chemical munitions stored in Okinawa.

Transport and diffusion models developed by Army atmospheric scientists were used in making hazard estimates for both of these operations, in the remote event of accidental release during movement of the toxic material.

For the forthcoming Army Automatic Meteorological System which ties in with the Tactical Operational System (TOS), computerized models are being developed that will provide dosage estimates over the battlefield, even over rough terrain.

Present meteorological predictions are made from widely spaced measurements. Correspondingly, confidence is reduced in dosage estimates and casualty probabilities. Using new Lidar tracer techniques and the RAMAN principle, real-time remote identification, tracking and measurement of aerosols in the atmosphere will be possible.

Although the Army lives and operates on the ground and in the lowest layers of the atmosphere, the Army also has an interest in the upper atmosphere because of the responsibility for providing the nation's ballistic missile defense (BMD).

Army atmospheric scientists are working to determine, quantify, simulate and model environmental conditions of the upper atmosphere through which the Safeguard Ballistic Missile Defense System must operate. Re-

(Continued on page 26)

WSMR Launches Sounding Rockets During Eclipse

Scientists of the White Sands (N. Mex.) Missile Range Atmospheric Sciences Laboratory launched a special series of meteorological sounding rockets at the Poker Flat, Chatanika, Alaska rocket range during the recent solar eclipse.

Eleven Arcas unguided rockets, launched between July 7 and 11, carried instruments to measure changes in wind, temperature and ozone levels which have been observed in the upper stratosphere during the period in which the solar radiation is blocked out by the moon.

Dr. Jagir S. Randhawa, research physicist specializing in atmospheric ozone, is principal investigator for the ASL experiment. Enlisted specialist Nelson Buck, an electrical engineer, provided rocket payload preparation.

Also aiding in the tests were John Sharpe, meteorologist and project impact predictor, and Delbert Bynum, who provided engineer technician and rocket preparation expertise. Radar tracking, general meteorological support and telemetry recording came from ASL's Meteorological Team, Alaska.

Data collected by the ASL rockets are being analyzed in an effort to gain a better understanding of the chemical, electrical and thermal behavior of the upper stratosphere and lower mesosphere. "It will take us several months to analyze all the data," said Kenneth Jenkins, chief of the ASL upper atmosphere research unit.

Past studies have shown a few degrees of temperature change and shifts of wind direction in the upper stratosphere during a solar eclipse. Also detected has been a slight fluctuation in the ozone level. Similar data can be obtained by firing the sounding rockets at dusk.

Atmospheric Sciences Laboratory personnel have fired over 7,000 rockets in similar atmospheric probes since 1957 at White Sands, in Alaska and Panama.

Army Atmospheric Sciences RDT&E Program

(Continued from page 25)

search is concerned primarily with events which take place in the D and E regions of the ionosphere.

The flow of ionized particles from the sun is coupled with events in the earth's upper atmosphere, the ionosphere, and is manifested in auroras, airglow, geomagnetic disturbances and resultant communication blackouts. It is essential to understand these upper atmospheric phenomena and to know what is there.

To answer these questions, rocket-borne sensors are lofted into space to obtain scarce and urgently needed data. These flights provide data with which atmospheric theorists construct mathematical models of the upper atmosphere, compute reaction rate coefficients for constituents of the upper atmosphere, and incorporate these rate coefficients into computer codes.

The first of these codes developed by Army atmospheric scientists is called AIRCHEM. This code is being used to calculate the deionization of the atmosphere following a nuclear burst.

As the upper atmospheric research program progresses, new and more complete computer codes will be developed to describe and predict the atmospheric environment that BMD systems will face.

Fog Dispersal/Dissipation. The Army research program currently is limited to local warm and/or cold fog dispersal/dissipation.

To accomplish this work, atmospheric fog and cloud models are being developed, the microphysical processes of fog and cloud formation and growth are being investigated, and the electrical structure of clouds is being studied.

It is interesting to note that there is an indication that some personnel detection sensors being tested under Project MASSTER are affected by the electrical forces generated by rapidly building clouds, especially those associated with thunderstorms. Results of this research are being applied to determine the extent of this interference.

Warm fog and clouds are a frequently occurring atmospheric condition throughout the world. They were a serious weather hazard in Vietnam, curtailing or aborting air-mobile, air-borne and aviation missions, and providing natural concealment for the enemy.

Army atmospheric scientists, together with their Air Force and Navy counterparts, have developed the helicopter downwash technique of warm fog and cloud dissipation. Currently, further studies are being carried on with the Navy to improve this technique.

Although still in the formative stages, this technique (initially conceived by the U.S. Army Cold Regions Research & Engineering Laboratory) has been employed successfully in Southeast Asia on a number of occasions. A lesson plan prepared by Atmospheric Science Laboratory researchers is being used in the training of Army helicopter pilots.

A practical operational test of the helicopter downwash technique is planned in the Gaillard Cut of the Panama Canal, starting in the fall of 1972. At the request of the Governor of the Canal Zone, Army and Navy scientists will attempt to dissipate warm fogs when they occur. Each year hundreds of ships are delayed in passing through the Canal during night and early morning hours due to the occurrence of warm fog.

The Army has developed a mobile cold fog propane dispenser that is ready for operational deployment. Because of the physical properites of cold fogs, modification/dissipation can be accomplished much more readily than for warm fogs. Although they do not occur with the frequency or areal extent of warm fogs, cold fogs are a problem in winter in the northern United States and Alaska.

Atmospheric Effects on Operations/Weapons Systems. As military technology becomes more complex, and is coupled with a requirement for all-weather capability, military operations have proportionally become more sensitive to atmospheric conditions.

A partial listing of Army functions on which atmospheric conditions have significant impact include:

- Sound-ranging and acoustics—the problem is how to correct microphone data for atmospheric refraction and distortion.
- Electromagnetic combat surveillance and target acquisition—the problems are how to choose the best devices for operational missions, the best wavelength for development of new devices, and how to correct electromagnetic data for atmospheric effects.
- Chemical and biological defense—the problems are how to assess the combined effects of terrain and vegetation on atmospheric diffusion and transport of vapor and aerosols; also, how to use atmospheric pressure, wind, dew, temperature and humidity measurements and predictions to forecast concentrations and viability on chosen areas for defense against attack by CB (chemical, biological) agents.
- Cannon, rockets (unguided), and missiles (guided)—the problems are how to aim cannons and rockets to compensate for atmospheric deflection, drag and weathercocking; how to design rocket—guidance systems to correct for deflection, drag, or weathercocking; and how to design pressure and other atmospheric fuzing systems.
- Nuclear weapons—the problem is how to anticipate the blast wave propagation and the intensity, location and time of radiological fallout and thermal radiation.
- Air mobility—the problem is how to obtain maximum air operations with minimum margin of weather safety.
- Surface mobility—the problems are how to anticipate when land areas or streams can be traversed, and how to develop mobility criteria for developing new vehicles. (These factors are influenced by atmospheric conditions, i.e., snowfall, snow and ice cover, rainfall, air and ground temperature, icing and low visibility due to dust, smoke, clouds and fog.)
- Communications—the problems are how to find new wavelengths not attenuated by atmospheric conditions and how to avoid mutual interference in new systems.

Theoretical approaches, laboratory experiments, *in situ* measurements utilizing rockets and high-altitude balloons, and remote sensing from the ground and from satellites, are being used to investigate the upper atmosphere, in an effort to understand ionospheric effects on communications, navigation, guidance and weapons systems behavior.

Army atmospheric scientists also are investigating the atmospheric conditions influencing missile structure, ballistic flight performance and onboard sensors or guidance systems of missiles.

Specific goals are (1) the development of realistic design criteria for use by engineers and designers; (2) the derivation of statistical data not readily available from standard observations; (3) the compilation of data from tactical areas; and (4) the advancement of the state-of-the-art on interaction between atmospheric environment and Army missile systems.

Research has been directed towards revision of the still inadequately defined design criteria for wind, density and pressure. If the Army's sophisticated and complex missile systems are to function without critical loss of performance, a realistic description of the global atmospheric environment is essential.

Past techniques used for obtaining this description have been deficient. Army atmospheric scientists have been successful in finding a solution, using the same information as previously but requiring only a small fraction of the computer storage.

The system includes the true vertical wind, temperature and density structure of the atmosphere. Atmospheric profiles can be readily calculated for any desired probability threshold. Therefore, analysis of the atmospheric influence upon missile systems and components can be performed with minimum cost, maximum efficiency, and missile engineers should be able to avoid over- or underdesigning.

This new technique has been successfully employed to study the environmental conditions from the surface to 25 kilometers and the wind profile from the surface to 5 kilometers for the Lance missile.

Atmospheric effects are considered of such importance that, in fiscal year 1973, the Army will establish a new project to investigate these effects on specific ballistic missile defense systems.

In conducting RDT&E it is usually necessary to know the actual atmospheric conditions under which the studies or tests were made. To provide this information, the Army conducts an extensive program of meteorological support to RDT&E activities.

This program is required to provide specialized support to Army RDT&E activities as specified in Army Regulation 115-10; provide support to White Sands Missile Range (National Range Documents), and to provide for Army participation in the Cooperative Meteorological Rocket Network (CMRN).

Meteorological teams provide support to installations which include White Sands Missile Range; Dugway Proving Ground; Tropic Test Center, Canal Zone; Arctic Test Center, Fort Greeley, Alaska; Yuma (Ariz.) Proving Ground; Project MASSTER, Fort Hood, Tex.; CDC Experimentation Center, Fort Ord, Calif.; Redstone (Ala.) Arsenal; Ballistic Research Laboratories, Aberdeen (Md.) Proving Ground; and the Natick (Mass.) Laboratories.

In addition, meteorological support personnel are participating in the Army's demilitarization and detoxification programs.

A substantial increase in the demand for

meteorological support by the Army RDT&E community has been developing in recent years. In fiscal year 1971, meteorological support was provided to 651 RDT&E projects at 11 permanent Army installations and at 20 temporary sites. At White Sands Missile Range, 120 RDT&E national programs were supported.

Army meteorological support personnel also participate in national and international research efforts, such as the Barbados Experiment (BOMEX), conducted above the ocean near the West Indies Federation, and the National Hail Experiment.

Army participation in the Cooperative Meteorological Rocket Network (CMRN) is carried on at three locations: Fort Greeley, Alaska; White Sands Missile Range; and Fort Clayton, Canal Zone, Panama. This rocket network in which the Navy, Air Force, AEC and NASA also participate, provides the major portion of data for the upper atmosphere available in the world. In fiscal year 1971, nearly 600 rocket firings were made at the three Army sites.

In concluding this program review, special mention must be made of the expertise in the Army's atmospheric sciences laboratories. The Army is fortunate in having extremely competent scientists in its laboratories. These scientists participate in national and international scientific organizations, and their research results appear in scientific journals as well as in-house technical reports.

The in-house laboratories have been successful in solving many Army atmospheric operational problems and also in anticipating future problems and needs of the Army in the field. The Army RDT&E community, as well as Army operational organizations, should recognize that this capability exists and use it more frequently.

Dr. Fernand P. de Percin is chief of the Atmospheric Sciences Branch, Environmental Sciences Division, U.S. Army Research Office, Office of the Chief of Research and Development.

Until the Environmental Sciences Division was reorganized, in February 1970, he was chief of the Special Projects Branch, a position he held since he returned to the USARO in May 1963 from almost two years with the National Science Foundation.

After receiving a BS degree in meteorology and climatology from Rutgers University in 1943, he entered the U.S. Army Air Corps as a weather officer. Following World War II, he earned an MS degree in meteorology and climatology at the California Institute of Technology and taught meteorology for a year at Pennsylvania State University.

In 1948 he entered federal service as a meteorologist with the Quartermaster Research and Development Field Office, Alexandria, Va., serving later as head of the office until 1953. He departed to become chief of the Polar Section and then of the Regional Branch at the Quartermaster Research and Engineering Command, Natick, Mass., until 1960. In 1955–56 he studied at Harvard University under the sponsorship of the Army and received a doctorate in meteorology and climatology in 1958. In 1960 he joined the Polar Branch, Environmental Sciences Division, USARO.

USAARL Studies Long-Range Troop Deployment Problems

(Continued from page 17)

Historically, soldiers have proved flexible, highly motivated, and capable of ingenuity and adaptation in time of stress. This has created a fighting force willing to go anywhere, any time, by any available means, and still remain effective in combat but long-range deployment may overtax man's adaptability.

Certain human factors and physiological parameters, however, are either fixed or adjust slowly to changing factors affecting performance. Among these are restful sleep, proper food, exercise, normal temperature, sensory stimulation, recreation and physical comfort.

Man's biological or circadian rhythms are difficult to alter, even over long periods of experimentally induced stress—let alone short exposures during a long trip by aircraft through changes in physiological factors.

Man's adaptation to sudden changes in environment, light to dark, sea level to high altitudes, arctic to temperate and tropical to desert, is slow and ill-defined. Some responses, such as biochemical changes, are known, predictable and quantifiable; all changes point to reduced effectiveness.

Variations in conditions of the three exercises mentioned earlier provided extremes for comparison. During Reforger I, frequent rest stops with meals were made. The aircraft were equipped with reclining, airline-type seats. All personal equipment was prepared at the site of debarkation and field maneuvers did not begin until 72 hours after landing.

USAARL staff observers of the three exercises have recommended that protection against aircraft noise be available, that better control of temperature and humidity be provided, that airline-type seats be furnished, and that nourishing, appetizing food be supplied. Other recommendations include adequate rest stops and the use of litters to allow for sleep on a rotational basis.

More definitive studies will be conducted by USAARL investigators to gain more precise information regarding aeromedical problems in long-range troop transport and to develop measures to minimize stress.

Recognition by strategic planners of the limitations of man, and institution by planners of the actions recommended, will continue a commitment to enable the combat soldier to perform at proper efficiency levels upon disembarkment from a long-distance aerial deployment.

Engineers Announce Design Award Winners

A flood control channel improvement in South Creek, tributary of the Pamlico River in North Carolina, is the 1971 Honor Award winner in the annual Chief of Engineers Distinguished Design Awards Program. Selections were made by many of the nation's foremost designers, architects and engineers.

Judges said this project, in the Landscape Architectural Design category, "has produced a fine natural area, aesthetically attractive and useful for fish and wildlife and related recreation, yet still accomplishing the stated objectives of channel improvements and flood control, and is an asset to the environment."

In the Architectural Design category, Awards of Merit were presented for 102 units of family housing at the Presidio of San Francisco, Calif.; the Officer's Open Mess at McGuire Air Force Base, N.J.; and the Sacramento Peak Observatory, Vacuum Telescope, in New Mexico.

Engineering Design projects cited for Awards of Merit included: the Regulating Structures (miles 140–154), Middle Mississippi River, in Missouri and Illinois; the C-5A field maintenance hanger, Dover Air Force Base, Del.; Broken Bow Lake, Little Red River, Okla.; and the New Dam, Lock and Dam No. 1, Green River, Ky.

In addition to the South Creek Honor Award, Awards of Merit for Conservation of Natural Beauty were given for the Wrightsville Beach Protection project in North Carolina and the Outlet Recreation Area, Pomona Lake, Kans.

Under General Landscape Development, another sub-category of Landscape Architectural Design, the San Antonio River channel improvement, in Texas and Lake Washington ship canal trail, Seattle, Wash., won Awards of Merit.

LTG F. J. Clarke, Chief of Engineers, said: "We hope and expect that the incentives provided by this competition will serve in some degree to provide an impetus toward continued striving by all concerned for improvement of the human condition."

Thrust Vector Control System for Advanced Interceptors

By Dr. Larry Atha

The purpose of thrust vector control (TVC) and aerodynamic surface control systems (fins and vanes) is to alter or regulate the trajectory of a vehicle in flight, i.e., to control its attitude at any instant.

Aerothermal problems encountered at hypersonic velocities limit the utility of fins and vanes and place more exacting requirements on TVC systems in terms of response time, duty cycle and forces generated.

To meet the stringent control requirements placed on advanced interceptor missiles, the Advanced Ballistic Missile Defense Agency (ABMDA) has developed a unique, lightweight, Thrust Vector Control system. Current antiballistic missile (ABM) interceptors utilize a liquid, secondary injection, TVC system. The liquid systems have limitations in the areas of system weight, duty cycle, packaging and maximum control force generation.

ABMDA's new system utilizes hot gases bled directly from the main rocket motor chamber to produce control forces through a combination of secondary injection thrust vector and jet interaction controls.

Secondary injection TVC is a technique in which a fluid (either liquid or gaseous) is injected into the rocket nozzle, causing an aerodynamic obstruction in the main stream of the

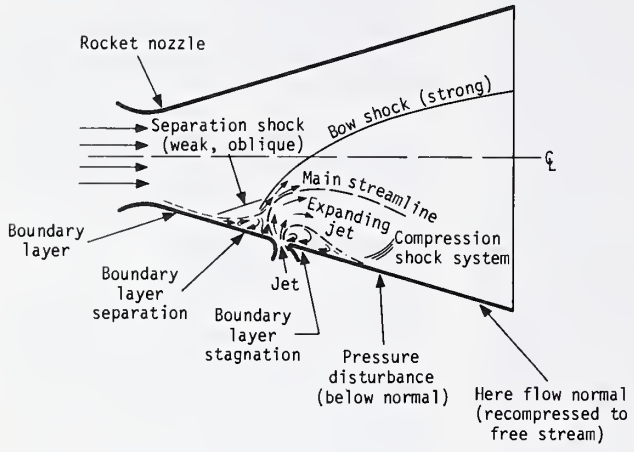


Fig. 1. Secondary Injection Thrust Vector Control.

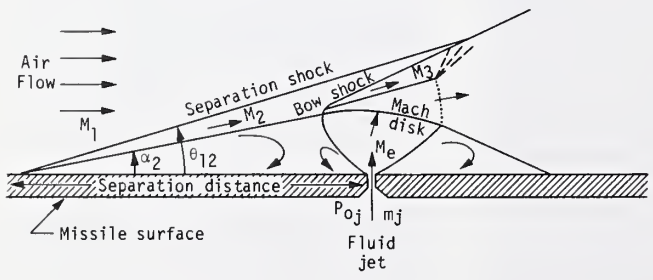


Fig. 2. Jet Interaction Control Flowfield.

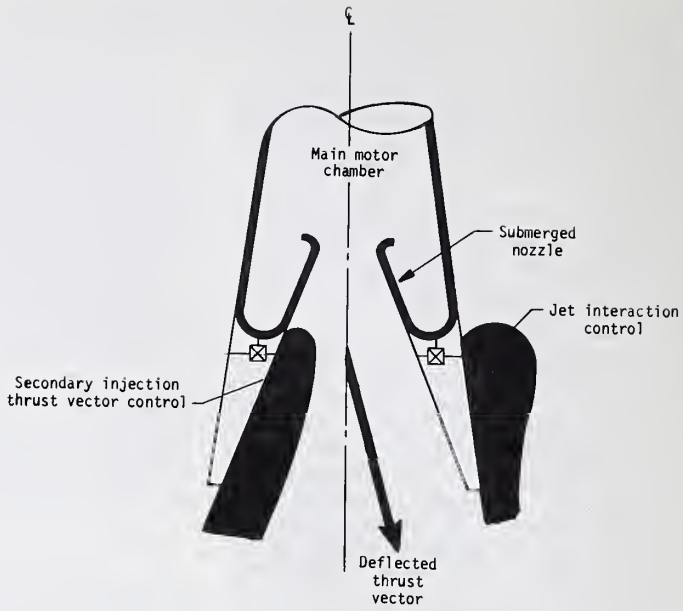


Fig. 3. Schematic of ABMDA's Thrust Vector Control System.

Fig. 4. Flightweight Hot Gas TVC/JIC Valve Test.

Dr. Larry C. Atha is a general engineer in the Missile Development Division, Advanced Ballistic Missile Defense Agency (ABMDA), Huntsville, Ala. From 1965 to 1969, he was an aerospace engineer with the U.S. Army Missile Command (MICOM) at Redstone Arsenal, a position he assumed after being MICOM's research and technical operations officer for two years.

Dr. Atha earned a BS degree in mechanical engineering in 1958 and an MS in the same field in 1960, both from the University of Missouri in Rolla, Mo. He holds a 1969 PhD from the University of Missouri in Columbia.

nozzle. This obstruction produces a shock wave and a boundary layer separation in the nozzle. It is accompanied by a positive pressure region on the nozzle wall near the injection port, resulting in a deflection of the thrust vector. A diagram showing the secondary injection flow field is given in Figure 1. A side force amplification for the secondary injection TVC results.

Jet Interaction (JI) is a technique that utilizes the injection of a gaseous jet into the airstream surrounding the missile to separate the boundary layer, producing a high-pressure region on the side of the missile. A significant side force amplification for the jet interaction force results. A diagram showing the JI flow field is given in Figure 2.

Factors influencing the design of a chamber-bleed hot-gas thrust-vector control (TVC) system include, in addition to overall performance requirements, the motor and propellant characteristics, missile flight characteristics, and available packaging space.

Each of these factors affects the individual valve gas flow rate, which in turn establishes the size and weight for the control system and its influence on missile performance. The motor and propellant characteristics—particularly pressure, temperature, burn time, and solid particle content—affect the heating rate, total heat impact and erosion. In turn, these factors determine the material to be used and the thickness required.

As for the missile flight characteristics, the dynamic pressure and angle of attack ranges affect the efficiency of the jet interaction system while missile acceleration determines the design limits of linear motion devices. Finally, the available packaging space limits the size of individual components.

Based on these as well as other considerations, the configuration for the current system was developed. The system is shown schematically in Figure 3.

Hardware has been developed to mechanize this concept in a comprehensive test and development program. Significant accomplishments were made in the areas of materials and manufacturing processes to contain the high-pressure, high-temperature, erosive hot gases from the main rocket motor for attitude control purposes.

A hot gas test of flightweight TVC/JIC hardware is shown in Figure 4.

Major Army RDT&E, Procurement Contracts Exceed $289 Million, Chiefly for Safeguard System

Army contracts for research, development, test, evaluation and procurement of materiel and services granted during the month of July, each exceeding $1 million, totaled $289,659,182.

Western Electric gained the largest award of $219,695,234 for research and development of the Safeguard Ballistic Missile Defense System, including computer systems work and engineering training aids.

Contracts under $10 million. E. D. Systems, Inc., $9,738,717 for radio receivers and transmitters; NHA, Inc., $6,208,000 for field team maintenance support of U.S. Army aircraft; University of Southern California, $5,987,055 for research studies; General Electric Co., $5,980,530 for manufacture and installation of generators and spare parts; Allied Research Associates, Inc., $5,552,108 for radar sets; Dahlstrom Corp., $5,301,370 for flood protection improvements.

Contracts under $5 million. C. A. Hooper Co., $4,594,500 for construction of support facilities at the Badger Army Ammunition Plant; Bank of America National Trust and Savings Association, $3,934,500 for banking and data processing services; Morweld Steel Products Corp., $3,099,416 for 105mm projectiles; Day and Zimmermann, Inc., $2,500,363 for loading, assembling, and packing of ammunition components; and

Beckman Construction Co., $2,285,000 for construction and modification work at the Holston Army Ammunition Plant; Teledyne Continental Motors Corp., $2,237,091 for cylinder sleeves and assemblies and piston assemblies for the M60 tank; Textron, Inc., $1,877,658 for mod kits for the UH-1D/H helicopters with spare sets; and

General Dynamics Corp., $1,773,975 for transmitting electromagnetic detecting sets (AN/GSQ-160); The Airport Machining Corp., $1,744,476 for high-explosive projectiles; System Development Corp., $1,317,565 for a training program for the Army Air Defense System; Goodyear Tire and Rubber Co., $1,303,290 for track shoe assemblies; and

Hughes Aircraft Co., $1,264,505 for repair and overhaul of depot operations; Union Carbide Corp., $1,177,371 for dry batteries used with radio sets; Radiation, Inc., $1,052,978 for common module encoders, and ancillary items; and Hercules, Inc., $1,033,480 for architect and engineer services and design of a nitroguanidine plant at the Sunflower Ammunition Plant, Lawrence, Kans.

SATCOM Developing Equipment For Use in Terminal Network

Defense Satellite Communications System new equipment is planned to increase substantially the transmission and receiving capacity of its earth terminals. The equipment is being developed through a $3.82 million contract under the technical guidance of the Army Satellite Communications (SATCOM) Agency.

A technique known as time-division, multiple-access will permit a single military communications satellite to be shared by a number of earth terminals.

Each terminal sharing a satellite transmits for a short period of time, then stops to permit each of the other terminals to operate in turn. Time periods are very short, measured in millionths of a second. Users are unaware of the continuous interruptions.

Highly reliable circuitry, with built-in fault location and circuit protection devices to keep transmission errors at a minimum, will be used. The units must embody nearly automatic controls.

The Defense Satellite Communications System is under the operational control of the Defense Communications Agency. The Army SATCOM Agency develops and deploys the earth terminals. The new equipment under development is part of Phase II of the Defense Satellite Communications System.

SATCOM engineers will conduct extensive tests in a terminal network before production is begun on field units.

COL Bass Takes Over New Demilitarization Post

Director of Demilitarization, a newly created position within the Headquarters of the U.S. Army Materiel Command, Washington, D.C., became the title of COL Samson H. Bass early in September.

COL Bass, who had served as commanding officer of Pine Bluff (Ark.) Arsenal since August 1971, during the period when it was phased out as one of the Army's two major centers for biological warfare, will be succeeded by COL George A. Lynn.

Pine Bluff, with a staff of about 1,300 civilian and military personnel, continues to perform functions in production of screen and signal smokes, white phosphorous, riot control agents and development operations.

As Director for Demilitarization, COL Bass is responsible for centralized management of the disposal of obsolete and unservicable chemical agents and munitions.

COL Bass has served as director of the Weapons Development and Engineering Laboratories, Edgewood Arsenal, Md., deputy, Chemical Operations Division, Headquarters, Military Assistance Command, Vietnam and as chief, Chemical Biological Weapons Branch, Office of the Chief of Research and Development.

Graduated from Virginia Military Institute with a BS degree in chemistry, he has an MS degree in business administration from Harvard University. He has graduated from the Army Command and General Staff College, and the Army War College.

COL Samson H. Bass

AMMRC Using X-Ray Crystallography in Materials Research

By Dr. James W. McCauley

Techniques for fabricating many promising new materials are being explored by Army Materials and Mechanics Research Center scientists to meet requirements for armor, laser rangefinder components, night-vision devices, gas turbine engines, high-temperature bearings and structures.

Ceramics experts are investigating methods of processing silicon nitride (Si3N4), single crystals of Al_2O_3 and $MgAl_2O_4$, ceramic-based composites and other special-purpose materials.

Properties of any of these materials depend on many factors, from the arrangement of atoms (crystal structure), interatomic bonding type, and atomic level defects of the constituent parts, to the configuration and flaw content of the final body.

Research on new materials demands sophisticated characterization, not only to optimize fabrication parameters and to insure future quality control, but also to provide property data for design engineers.

X-ray crystallography is the basic tool used to characterize both single crystals and polycrystalline bodies. By this technique, impinging X-rays are reflected (diffracted) from materials in varying direction and amount depending on the type and arrangement of the constituent atoms. Suitable electronic or photographic equipment can be placed around the material under study to record the various positions and intensities of the reflections.

X-ray crystallographers have made many significant contributions to engineering disciplines as well as medical research. Solution of the atomic structure of DNA has opened up whole new avenues of understanding in genetics. The recent solution of the crystal structure of insulin may do the same for diabetes.

Crystallographers are making important contributions to the understanding of human calculi (kidney, urinary and gall bladder stones) and the formation of caries in teeth. The effect of heavy metals, like mercury, on the human nervous system may also be unraveled by X-ray crystallography.

Material scientists, on the other hand, are concerned about specific properties like strength, electronic conduction and transparency, controlled by the chemical composition and impurity content of materials. These material properties can now be monitored routinely by crystal structure analysis and precise lattice parameter measurement—the latter being the geometric measurements of the smallest orderly atomic unit in the solid.

Silicon nitride (Si_3N_4), is being seriously considered as a new material for turbine engines, in that, theoretically, it may enable them to operate at close to maximum efficiency.

Detailed X-ray crystallography of various forms of Si_3N_4 has shown that the presence of minute quantities of oxygen will result in the formation of $Si_{11.5}N_{15}O_{0.5}$ and not pure silicon nitride.

Single crystals of $MgAl_2O_4$ (spinel) are also being fabricated at AMMRC for potential use as electronic substrate material. For this use, the composition must be kept as constant as possible; otherwise catastrophic failure of whole circuits could occur. This can be monitored easily by precise lattice parameter measurement.

AMMRC scientists have demonstrated that sophisticated X-ray and optical crystallographic methods could be used to optimize the reproducible fabrication of sapphire discs for transparent armor applications (see *Army R&D Newsmagazine,* page 42, May-June 1970).

The total applicability of X-ray crystallography is not limited, however, to characterization of existing materials; it also can be used to predict new materials. Composites are being fabricated at AMMRC by using synthetic mica as a nonbrittle component in a brittle ceramic matrix.

This investigation was preceded by an in-depth investigation of the crystallography of micas, resulting in mathematical formulae which can be used to calculate the crystal structure of any mica.

Composition of mica can be formulated as follows:

$X_2 Y_{4-6} Z_8 O_{20} (OH, F, Cl, etc.)_4$,

where X = Na, K, Rb, Cs, Ca, Sr, Ba, Pb, (La^{3+}?), etc.
Y = Al, Fe, Mg, Ni, Li, etc.
Z = Si, Ge, Al, Fe, B, Be, etc.

Obviously, hundreds of mica compounds are possible. The fundamental unit of the mica crystal structure is the tetrahedral sheet network pictured in two of many possible configurations in Figure 1. It is an array of ZO_4 (the large circles are oxygen atoms) tetrahedral units joined together at three corners. This sheet can be characterized by two parameters, α and Δ, both of which can be calculated merely from a knowledge of the chemical composition:

α (°) = 218.0 (b_i/b_o -1.5 (FS) - 221.5
Δ = 0.047 (α),

Where: α = angle of rotation of tetrahedra from an ideal hexagonal array,
Δ = difference between the mean outer and inner interlayer cation–tetrahedral oxygen distances

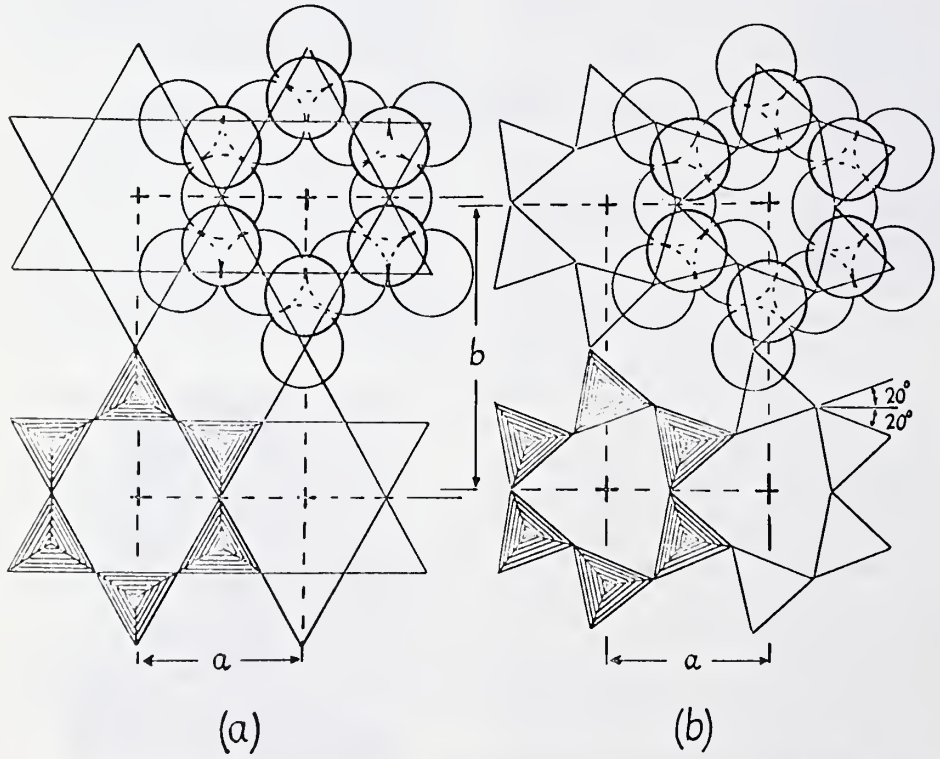


Fig. 1. Two possible configurations of tetrahedral sheet network of mica.

Dr. James W. McCauley has been working as a research chemist in the Materials Research Laboratory of AMMRC, since September 1968. His education includes a BS in geology from St. Joseph's College, Rensselaer, Ind., an MS in mineralogy from the Pennsylvania State University, and a PhD in solid state science, also from PSU.

His research activities at AMMRC involve both synthesis and characterization studies. He is currently working on the fabrication of ceramic-based composites, the characterization of Al_2O_3 and $MgAl_2O_4$, and crystal growth of slightly soluble materials by the silica gel technique. He also maintains a liaison in fluidics for AMMRC.

(the interlayer cation is located in the center of the tetrahedral sheet),

b_t = b dimension (see Fig 1) of ideal tetrahedral array,

b_o = b dimension of ideal octahedral array, and

FS = ratio of interlayer cation valence to ionic radius.

Figure 1b shows a tetrahedral network where α is 20°. For an ideal hexagonal array where $\alpha = 0$, Δ is equal to zero, that is, all the interlayer cation–oxygen distances are equal. As α changes from zero the magnitude of Δ increases.

Since the properties of these micas are controlled by their composition and, therefore, by their structure, it follows that micas can be used to tailor-make composites for specific applications.

As an example, mica-alumina (Al_2O_3) composites, which show a range in flexure strength from 25,000–45,000 psi and elastic modulus from 28,000,000–50,000,000 psi, have been fabricated at AMMRC. These changes have been accomplished simply by replacing K by Ba in the mica. Other properties, such as dielectric strength, could be varied as well and will be investigated in the future.

Because there will be a large increase in the use of single crystals and new materials in many Army systems in the next few years, it is critical to the Army mission to develop sophisticated characterization methods, such as X-ray crystallography, to evaluate and monitor the properties and quality of future materials.

Secretary of the Army Froehlke Commends 2 Suggestors as 1971 Economy Champions

A civilian and an Army warrant officer were cited recently as the FY 71 economy champions in Pentagon ceremonies officiated by Secretary of the Army Robert F. Froehlke.

Billy J. Bryant, a special projects officer for the U.S. Army Strategic Communications Command's (STRATCOM) Communications Electronics Engineering Installation Agency—Western Hemisphere, was honored for saving the government more than $1 million during the fiscal year. He submitted five suggestions on communications improvements to earn $4,000 and the Meritorious Civilian Service Medal.

The military honoree was CWO James R. Thomas, presently assigned to the 426th Signal Battalion at Fort Bragg, N.C. He received a $6,000 check and a Meritorious Service Medal for his contribution, which involved the design and development of the Terminal Telegraph AN/MGC 34. This equipment is now in use Army-wide.

Interesting facets of persistence and individual know-how make up the story of its development. For CWO Thomas it began while he was stationed with the Army Security Agency in Europe, where he did some preliminary thinking about possible improvements in the old teletype system.

The idea was interrupted, however, by his return to the states to an assignment at Fort Sill, Okla. But, not for long. When he learned of the formation of the 11th Air Assault Division for duty in Vietnam, CWO Thomas was impressed by the need being publicized for highly mobile equipment.

Believing that he had at least part of the answer for signal equipment, he requested and was given an assignment to Fort Benning, Ga., where the 11th was being activated, to work on his ideas.

By March 1963 CWO Thomas had put together the first model which, in the absence of any funds, was a mock-up made of wood. The unit worked well enough and he was given access to the post salvage yard.

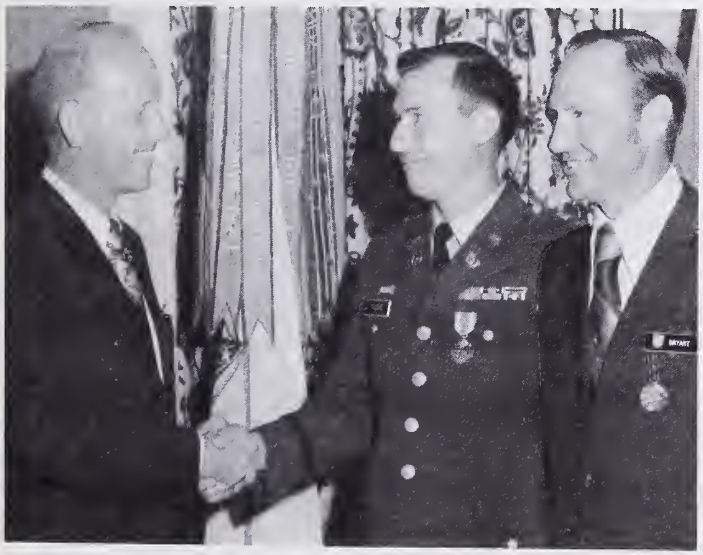
"One of the biggest advantages of the AN/MGC 34 is that it is lightweight and highly mobile," CWO Thomas said at Fort Benning recently, "but you couldn't have known that from the first model we constructed out of metal. Because we had to use what was available through the post salvage yard, the first one was made of angle iron and galvanized pipe, and you can believe it was heavy."

This first metal model finally convinced any remaining skeptics, and the Army sent CWO Thomas to the signal testing facility at Tobyhanna, Pa., to further develop his system. There he had the advantage of working with several specialists in the electrical and metals durability fields and of having appropriated funds to purchase materials.

"This was a big step," he said, "because it marked a change in our work from a sort of catch-as-catch-can thing to a funded research project."

By 1965 the teletype equipment was ready for the final test. CWO Thomas brought his new system to Fort Benning, Ga., where six of them were constructed and sent with him to Vietnam.

Their test "under fire" conclusively proved the new system's worth. Because of its lightweight and capability of being sling-loaded, units in Vietnam began clamoring for the equipment. In short order, the 1st Cavalry, 101st Airborne and 1st Infantry Divisions started using the system, with much success.



SECRETARY OF THE ARMY Robert F. Froehlke shakes hands with CWO James R. Thomas after congratulating him and Billy J. Bryant as the 1971 military and civilian economy champions.

Symposium Focuses on Insulated Pavement

Use of insulation in airfield and highway construction was considered by about 70 representatives of the Army, Air Force, Navy, National Research Council, Federal Aviation Agency, State Highway Departments, National Research Council of Canada, and industry at a recent symposium.

Topics discussed at the U.S. Army Cold Regions Research and Engineering Laboratory (USACRREL), Hanover, N.H., included the structural response of insulation within the pavement system, and problems associated with construction provisions.

Parametric considerations included selection of specific insulation based upon cost, strength properties, thermal properties, potential degradation caused by loading and/or environmental effects; ease and speed of construction; and the effect of insulation on the existing criteria for drainage provisions.

Potential operational problems also were discussed such as development of frequent icing, differential icing either between pavement sections having differing amounts of insulation or between insulated and uninsulated sections, and development of bow waves in the pavement due to placement of the insulation at shallow depths.

North Smith and Richard Berg of USACRREL were cochairmen.

Army Evaluates Cold Regions Research

U.S. Army Materiel Command Ground Mobility Research Program Steering Committee activities were reported at a recent meeting at the U.S. Army Cold Regions Research and Engineering Laboratory (USACRREL), Hanover, N.H.

USACRREL staff members discussed their cold regions mobility research program and similar progress reports were presented by representatives of the U.S. Army Test and Evaluation Command and the Army Corps of Engineers Waterways Experiment Station.

Committee members in attendance included chairman R. C. Navarin and J. P. Carr, Army Materiel Command; Dale E. Woomert, Army Materiel Systems Analysis Agency; Paul F. Carlton, Office of the Chief of Engineers; Stanley H. Miller, Office of the Vice Chief of Staff, HQ DA; and Dr. Valentine Zadnik, Office of the Chief of Research and Development, HQ DA.

AF Smart Bombs

Army Research Yields Laser-Guided Missile Technology

(Continued from page 5)

size a solution to technical problems by pulling together bits of diverse technology and figuring *how* to make them fit."

Synthesizing this solution took months. Often working alone for days at a time, Salonimer also drew on the specialized knowledge and skills of other members of the Missile Command research team and his widespread contacts in defense industry. He polished his evolving thoughts in the chalk board group think sessions much favored by engineers.

Of those latter sessions, Salonimer says: "You can't underestimate the importance of the 'devil,' the guys on the negative side, who say 'That won't work and here's why.' Opposition keeps an idea alive. When everyone agrees, you run out of steam."

The original thinking had been that the laser must illuminate with continuous energy, roughly analagous to pointing a flashlight at a target, switching it on and holding the beam on the target until the missile hit.

Searching impatiently for a way to get away from the large power source that approach would require with laser technology then available, Salonimer came up with the idea of pulsing the laser beam. In effect, he proposed illuminating the target with regularly spaced short bursts of very high energy. That was a way to do the job with a relatively small power source if he could find answers for a host of new problems that approach presented.

When he assumed the laser could be pulsed, Salonimer found the pieces of his technical jig saw puzzle came together. He mathematically proved that his theory was correct.

"Dave's equations were the road map," Norman recalls. "Once we saw them, we had the way to go."

New technology of great promise attracts widespread interest throughout industry and government research organizations. By late 1962, that kind of interest had begun to accelerate laser technology. Once the snowball started downhill, the Missile Command, as the advocate of the laser guidance concept, became the focal point for ideas that poured in.

Salonimer recalls: "People would come in and offer ideas. Some probably didn't even know that they had helped. None of us could tell you today where it all came from. We were sitting right in the middle, pulling it together, shaving off what we didn't need, urging the laser guidance concept on any one who would listen."

Some of the urging involved pointing out how laser-guided weapons might be used in combat. The Army traditionally has used forward observers, men in position to see the target, to adjust the fire of cannons. Now it appeared that a forward observer, using a laser illuminator, could literally steer the weapon right to the target. If the illuminator could be made, it could be used almost anywhere; by a soldier in a foxhole, or mounted on jeeps, tanks, helicopters or airplanes.

The airborne illuminator was one of many suggestions Salonimer advanced as he urged industry to consider the feasibility of laser guidance.

The process through which weapon systems evolve from thoughts into full-scale development programs which produce useable military hardware, in the early stages, is essentially one of predict, then confirm. In June 1963, the Missile Command sought the first vital confirmations.

Autonetics and RCA received contracts totaling $156,000 to investigate different technical approaches for seekers to home on pulsed laser radiation. Within six months both the Autonetics concept using solid-state devices and the RCA television image tube technique had been successfully demonstrated under laboratory conditions.

As an offshoot of this effort, Autonetics developed, on its own, a relatively lightweight pulsed laser that could be used as an illuminator in experimental setups. Salonimer, one of several Missile Command engineers, who saw the crude device reflect its beam off a brick wall on the far side of a parking lot at the Autonetics plant, recalls: "At that point we knew what we wanted was within reach."

Based on the highly promising initial reports from its contractors and the results of work continuing in its own laboratories, the Missile Command now began to shift the impetus of its effort toward hardware: seekers that could be tested, first on the ground, then flown in missiles, portable illuminators that could be operated on test ranges.

In January 1964, development work on a portable illuminator got under way in the Redstone laboratories. A few months later additional contracts funded further seeker work. Awards to two industrial firms funded other possible technical ap-

Watervliet Arsenal Researchers Ease Grenade Test Firing Problems With New Fixture

Difficulties encountered in test firing 40mm infantry grenades, attributable to round-to-round and lot-to-lot variation, may be reduced by use of a new test fixture designed and developed by the Special Projects Division, Watervliet (N.Y.) Arsenal.

The fixture is a precision-built, single-shot weapon, consisting of a 40mm gun barrel, a screw block breech and a firing lock secured to a base plate. Technicians can observe and record possible variations in each grenade as it is fired.

Several of the fixtures have been shipped to various Army proving grounds, following successful preliminary testing.

The design team consisted of project leader John J. Busuttil, mechanical engineers John K. Jorczak and Ronald G. Gast, and mechanical engineering technicians Anthony J. Rinaldi and Matthew Sroczynski.

The project was carried out under the direction of the commodity manager for rifles in conjunction with the project manager for selected ammunition and the Small Arms Systems Laboratory, Army Weapons Command.

THREE of the Watervliet Arsenal design-team members responsible for developing this single-shot weapon, which will help in determining the nature of difficulties encountered in test firing 40mm infantry grenades, are (from left) Walter H. Austin Jr., chief of the Special Projects Division, John K. Jorczak and Anthony J. Rinaldi.

proaches to the development of the laser illuminator. One of them, Martin Orlando, subsequently delivered a practical pulsed laser illuminator weighing less than 40 pounds.

Military research organizations exist to produce good ideas, but not all good ideas go on to become weapons. Once a solid technical foundation begins to support theory, other factors become increasingly important—such as cost of the proposed weapon and what it offers in the way of improved fighting capability to the service supporting the research.

Contrary to popular belief, each military service does not jealously guard the results of its research programs from the others. In fact, there is a continuous exchange of information at several levels, ranging from Defense Department sponsored tri-service working groups down to informal discussions among individuals in government laboratories and their supporting defense contractors.

Just that sort of an exchange had been going on in laser semiactive guidance. Salonimer and a colleague, Norman L. Bell, have been serving as the Missile Command's primary points of contact with interested groups in other services and industry research organizations.

Bell recalls: "Dave organized the exchange. It was very informal but we were talking back and forth to the other people to make sure that everyone knew what was happening."

Encouraged and supported by the Missile Command's pioneering work, the Air Force evidenced definite interest in laser guidance in the spring of 1964, an interest that grew throughout the year. Bell soon found that in addition to working out potential development programs for Army laser-guided weapons, he had become the Missile Command's informal ambassador to the Air Force.

The Redstone group had decided by then to pursue solid-state technology for the seeker, believing it offered the best approach for a high-accuracy missile guidance system. The RCA image tube technique was diverted into a way to mark ground targets for pilots of attack aircraft.

By the end of 1964, sled testing on the Autonetics solid-state seeker had begun at Redstone, Martin's first illuminator was nearing delivery and RCA had the target designation system ready for demonstration in an aircraft.

In short, as 1965—the year of initial major commitment of American combat forces in Vietnam—began, the technology needed to make a laser-guided weapon was well in hand.

At the invitation of the Air Force, Bell and Salonimer attended a meeting in Orlando, Fla., in April 1965. Looking back, both men agree that session was a critical, perhaps the most critical, point in the evolution of the smart bomb.

The Air Force called the meeting to review the status of laser guidance technology and how it might be applied. In essence, the questions of overriding importance discussed in the 2-day session were: "Is the technology available now to support a development program for laser-guided weapons? How can they be used in tactical air warfare?"

Bell recalls: "As it turned out, Dave and I were the only technical types in the room who could talk in terms of both the technology and how it could be used in weapon systems. We had done our homework on applications."

The two Missile Command representatives answered the first question with an unqualified yes, then outlined several weapons concepts tailored to Air Force application. In particular, they talked about the laser-guided Shrike.

Looking for a relatively inexpensive missile for its own concept, the Missile Command had brought Texas Instruments Co. into its effort in mid-1964—by funding studies leading to integration of a laser seeker in the Shrike missile, a Texas Instruments product.

Bell and Salonimer explained to the Air Force representative at the Orlando meeting the mechanization of the laser-guided Shrike, how it could be put into another missile, or a free-falling bomb.

A month later, in May 1965, the Air Force formally asked the Missile Command to participate in a short and quick demonstration program to establish the practicality of laser-guided bombs and their anticipated greater effectiveness.

Specifically, the Command was asked to provide laser illuminators and operators, technical assistance and evaluation of the seeker proposals of the contractors selected by the Air Force to work on the bomb.

What the Air Force had in mind was a development program aimed at producing a relatively inexpensive modification kit to be fitted on a standard bomb—a simple seeker to home on laser illumination, coupled with moveable fins that would cause the bomb to maneuver as it fell toward the target and achieve much greater accuracy.

Able to rely on the Missile Command for illuminators—Martin had delivered one in January 1965 and had received followup orders from the Command to build two improved models—the Air Force concentrated on the bomb modification.

Contracts were awarded to Autonetics and Texas Instruments. Autonetics had been deeply involved in the Missile Command's program for two years. Texas Instruments, building on what it had learned from the Missile Command during the studies on the laser-guided Shrike, had submitted an unsolicited proposal to the Air Force for a laser-guided bomb.

In the next 18 months, with Bell coordinating the effort, the Missile Command illuminators were used by both the Air Force and its contractors in developing and testing the laser-guided bomb. Salonimer and others at Redstone provided advice and assistance to the Air Force, including detailed evaluation of the contractors' technical proposals.

Autonetics, with its longer experience, appeared the obvious choice. Texas Instruments offered an approach of higher risk, but potentially simpler and lower cost. Salonimer spotted that and urged the Air Force to fund both approaches.

Texas Instruments eventually won the competition and went into quantity production. The Martin Co., which built the first illuminators for the Missile Command, later developed the aircraft-mounted illuminators for the Air Force.

Building on the technical base developed by the Army programs, the Air Force and its contractors were able to bring the smart bomb along in a very short time. Well launched by successful demonstration in 1966 of the laser-guided bomb, the Air Force went ahead in an expedited program to ready the weapons for operational use.

The laser-guided weapon, as a result, went into its first combat as a smart bomb. McDaniel explains why:

"The group working on laser guidance here at the Missile Command had been working to Army requirements, looking for a better way to fight tanks. The enemy was not using tanks in the early years of the Vietnam War. The Army had a good concept, but no targets.

"The Air Force, on the other hand, had targets, plenty of targets. They wanted a way to hit them more effectively. They obviously got it. The Missile Command group continued to expand laser-guidance technology for application to Army requirements. That was our primary goal from the outset."

Today Salonimer can see a laser-guided missile by getting up from his desk in the Missile Command research and engineering laboratory and taking a short walk down the hall. Army laser-guided long-range rockets have demonstrated unprecedented accuracy. Air-to-ground laser-guided missiles are fired regularly at Redstone Arsenal test ranges.

Salonimer's pile of newspaper and magazine clippings offers positive evidence that the smart bomb has introduced a new dimension in warfare. He feels it is just a beginning. "We've hardly scratched the surface of what can be done with laser guidance," he said, outlining a dozen potential applications.

Someone asked if he had ever seen a smart bomb tested. He seemed surprised by the question but replied: "No, I never did, but that wasn't important. We knew it would work."

IN RETROSPECT . . .

(Continued from inside front cover)

venture. Pridefully, however, the editors like to believe the Newsmagazine has published, with the aid of contributors and information officers, as well as by dint of diligent digging, a very substantial number of R&D reports of vast significance, militarily and in civilian benefit byproducts.

Not until Dec. 1, 1961—a full year later—was it officially announced that worldwide synchronization of atomic clocks, to the precision of millionths of a second, had been achieved in Project WOSAC.

The release stated that tests between New York State, South America, Hawaii and Australia revealed that the clocks were synchronized "within an average 3.5 millionths of a second (3.5 microseconds) during a 10-day experiment." The release continued:

"Among other purposes, the close measure of time thus achieved will be of great value in tracking satellites and intercontinental ballistic missiles, for global communication systems, and radio wave studies. . . . Intercontinental communications cables, even if they existed at all the points where they might eventually be needed, do not provide sufficiently stable transmission for attaining the accuracy needed for synchronization of atomic clocks."

The element cesium, whose atomic structure can be made to resonate at an unalterable rate of 9.1 gigacycles—a "tick" every tenth of a nanosecond—is the heart of the atomic clock. About 100,000 times more accurate than the rotation of the earth as a timekeeping standard, the atomic clock gains or loses only one second every 30,000 years.

As defined for the use of an atomic clock, "the second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the fundamental state of the atom of cesium 133."

This approach to precise time is interrelated with U.S. Army research in atomic and molecular frequency control to pinpoint the international unit of time—the second—to the standard needed for fully military tactical time synchronized worldwide.

Comparisons are necessary because the U.S. UTC (Universal Time Coordinated) scales, by international agreement, must be related accurately to the UTC (BIH—Bureaue Internationale de L'Heure) scale. International agreement permits up to 1,000 microseconds difference. Even this small difference was virtually eliminated on Jan. 1, 1972 when most UTC scales were adjusted slightly. The present difference is estimated to be less than 3 microseconds.

The BIH in Paris is charged with generating an International Atomic Time scale (IAT) from the various time scales maintained in the participating countries. It maintains this scale as an international reference for comparison with all other scales, and as a base for generating the UTC (BIH) scale.

All participating countries must then maintain their own UTC scales within 1/1000 of a second of UTC (BIH). Why must such a close tolerance be maintained? Primarily to avoid international ambiguities when specifying the exact time that events occur, especially scientific or astronomical events.

If nations generate their own independent time scales with no provision for coordination, these scales will tend to diverge over the years, until, conceivably, 8 o'clock in the United States would coincide with 8:30 in Canada. Time scales diverge because clocks are not perfect, even atomic clocks. They all run at slightly different rates, and only by periodical resetting can close agreement be kept.

The UTC (BIH) scale, the standard of comparison for all the others, is controlled by reference to the BIH International Atomic Time scale (IAT). The IAT scale is a "paper" scale constructed by taking a weighted average of the atomic time scales of the participating countries.

Seven laboratories in the United States, England, Canada, France, Germany and Switzerland generate atomic time scales. These are weighted and used to generate the BIH IAT scale. UTC (BIH) is then adjusted to be an integral number of seconds different from IAT. (Currently, UTC (BIH) is 10 seconds later than IAT.)

Methods of comparing the various national scales and the BIH scale depend on the accuracy needed. Routine comparisons often employ radio transmissions such as LORAN-C. These transmissions are usually in the low to very-low frequency range to avoid propagation errors of high-frequency waves.

More accurate comparisons require carrying portable atomic clocks from one laboratory to another. For instance, NBS can note the difference between a portable clock and the UTC (NBS) scale as maintained by the Time and Frequency Division in Boulder, Colo. Then the clock is put on an airplane (it occupies a seat in the first class section, where it can be plugged into the aircraft's power system) and flown to Paris.

There, its reading is compared to the UTC (BIH) scale and the difference noted. Subtracting one difference from the other yields the difference between UTC (NBS) and UTC (BIH), and by calculation, the difference between NBS atomic time and BIH atomic time. Thus, the relations between the NBS scales and the BIH scales are established, and adjustments can be made to the UTC (NBS) scale.

So, the next time you notice a ticking instrument strapped into the airliner seat next to you, and plugged into the wall, don't panic. Just ask it if the plane is on time. It will know.

People in Perspective . . .

Dr. Baldes Retires From Federal Employment Ending Two Careers Spanning Half Century

Two distinguished careers spanning 50 years—the most recent one begun at the age of 65 with the U.S. Army Research Office (USARO)—ended recently when Dr. Edward J. Baldes retired from federal employment at the age of 74.

Dr. Baldes retired as scientific adviser at the U.S. Army Aeromedical Research Unit (USAARU), Fort Rucker, Ala., a post he held more than four years after leaving USARO in 1967. His federal service began in 1963 when he joined USARO's Scientific Analysis Branch, Life Sciences Division.

Associated for 40 years with the Mayo Clinic, Rochester, Minn., Dr. Baldes was senior consultant in the Biophysics Section from 1959 until he entered federal service. For 10 years he was director of the Clinic's Physical and Biophysical Research Division.

Dr. Baldes also was a professor of biophysics at the Mayo Foundation for Medical Education and Research, University of Minnesota Graduate School, and vice chairman of the Mayo Aeromedical Unit. From 1942 to 1949, he served as a special civilian consultant to the Aeromedical Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio.

In recent years with USAARU, Dr. Baldes has been involved in research related to the aeromedical aspects of biophysics, physiological optics, experimental psychology and aviation physiology.

In addition to studying problems of vision, hearing and the toxicity physiology changes associated with high altitudes and free fall, USAARU research is concerned with problems of medical evacuation of personnel in combat zones.

In 1968 Dr. Baldes received the Eric Liljencrantz Award for his basic research in the biophysical sciences—the climax of a long list of honors bestowed in recognition of outstanding achievements in scientific investigations. In 1969-70 he received two additional Certificates of Commendation for Outstanding Performance of Duty.

Cdr. Eric Liljencrantz, MC, USN, recorded a brilliant career in Aviation Medicine until killed in an airplane accident in 1942. The award memorializing him—given annually for the best paper in basic research in the problems of acceleration and altitude—was established by Charles Pfizer and Co., Inc.

At an important 1971 symposium of the NATO Advisory Group for Aerospace Research and Development in Portugal, Dr. Baldes presented the introductory paper and coordinated arrangements for U.S. participation.

The symposium focused on the key word IMPACT—for example, the question: "What impact can man withstand to his head or to his body when he falls from a high building or bridge, or when a parachute fails to open, or when he slips and strikes his head on ice?"

Dr. Baldes stressed the importance of in-depth reviewing of recent aviation and automotive research, and increasing knowledge of impact stress on man.

A 1918 graduate of the University of Saskatchewan, Dr. Baldes holds MA and PhD degrees in physics from Harvard University (1920 and 1924), and a PhD in physiology from University College, London, England (1936). He is the author or coauthor of more than 175 scientific publications in biophysics, physiology and aviation medicine, and an active member of more than a dozen scientific societies.

Dr. Baldes has served on the Advisory Panel on Science and Technology to the Committee on Science and Astronautics, House of Representatives, U.S. Congress. He also served on the Aerospace Medical Panel and the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization.

Dr. Edward J. Baldes

For his design of special centrifugal devices which contributed to the safety of American aviators in World War II, Dr. Baldes was awarded the War Department Commendation for Exceptional Civilian Service in 1948. He has also received the Chevalier de la Legion d'Honneur from France and was awarded the Knight of St. Gregory the Great from England.

When he began the last years of his federal service with USARRU, Dr. Baldes termed it "possibly the most important job in my life. . . ." His work there attests to the undiminished dedication of this man who continued to seek new challenges at times when others his age were content with a life of retirement.

Dr. Kushner of NBS Heads Unit On Federal Laboratory Problems

Dr. Lawrence M. Kushner, acting director of the National Bureau of Standards, has been appointed chairman of the Federal Council for Science and Technology's Committee on Federal Laboratories.

This standing committee provides a forum through which science-administrators, representing federal agencies, deal with mutual problems.

The committee analyzes policy matters relating to operations of the federal government's more than 700 research and development establishments, cooperative federal laboratory-university arrangements, laboratory utilization, federal employment of scientists and engineers, and associated questions.

Retirements Drain Wealth of Army R&D Talent

Hundreds of veteran scientists, engineers and skilled technicians were recently lost to the Army when more than 40,000 employes retired from federal service to receive the benefit of a 4.8 percent cost of living increase.

Normally about 5,000 federal employes retire each month, but the increased annuity, payable to retirees meeting the June 30 deadline, triggered a mass exodus that cut deeply into the Army in-house laboratories' wealth of exceptionally diversified experience.

Picatinny Arsenal, Dover, N.J., alone lost 10 engineers whose cumulative federal service totaled 282 years. Sixteen employes at the Deseret Test Center, Fort Douglas, Utah, retired with a total of 384 years of U.S. Government service—four with more than 30 years each.

At Rock Island (Ill.) Arsenal, one division of the Logistics Support Directorate lost 25 employes with more than 653 years service at the arsenal. Four White Sands (N. Mex.) Missile Range retirees averaged 31 years each.

Key activities of the U.S. Army Missile Command (MICOM), Redstone Arsenal, Ala., affected by the retirement rush included such well-known missile system projects as the SAM-D which lost seven experienced employes; the Hawk, 3; Pershing, 3; TOW, Chaparral, and Dragon, 1 each.

Rock Island (Ill.) Arsenal lost Elmer I. Rowlands with 32 years experience, all except one month in data processing.

Too many exceptionally well-known individuals retired with more than 30 years service in Army R&D activities to list them all.

Some of them are Dr. Richard A. Weiss, Deputy and Scientific Director of Army Research, Office of the Chief of Research and Development; Dr. S. L. Gerhard, research physicist at Picatinny Arsenal; Frank A. Carn, Deseret Test Center; Hyman Graus, military engineer with the U.S. Army Mobility Equipment Research and Development Center; Harry M. Hess, scientist at Aberdeen Proving Ground; Jerome Lebowski, engineer at MICOM; Morris M. Buch, U.S. Army Tank-Automotive Command (TACOM); Clyde T. Baker, electronics technician at White Sands Missile Range; Elaine A. Israel, Frankford Arsenal.

With more than 50 years of combined service, William H. Whalen and his wife Camille said "Farewell" to MERDC where he had worked in the Standardization Division since 1942. Mrs. Whalen had over 20 years with the Equipment Management Office.

Career Programs . . .

MG Designees Include 6 R&D Career Officers

President Nixon's approval of 34 officers for promotion to temporary rank of major general includes six enrollees in the Army Research and Development Officer Program, designed to build an elite specialists group.

They are BGs William J. Maddox Jr., Peter G. Olenchuk, Patrick W. Powers, Sylvan E. Salter, Thomas H. Tackaberry and Wilbur H. Vinson Jr.

BG MADDOX is director of the Army Aviation Office, Assistant Chief of Staff for Force Development, Washington, D.C. He was a staff officer, Office, Chief of Research and Development (OCRD) in 1961-64 prior to his assignment as CO, 13th Aviation Battalion, Vietnam.

Other key assignments have included: chief of staff, and later assistant division commander, 3d Armored Division, U.S. Army, Europe; CO, 3d Brigade, 25th Infantry Division, U.S. Army, Pacific; and CO, 164th Combat Aviation Group, U.S. Army, Pacific.

Graduated from George Washington University with a BS degree in international affairs, he also holds a BA degree in journalism from Michigan State University. He has graduated from the Army Command and General Staff College and the National War College.

His military honors include the Silver Star with three Oak Leaf Clusters (OLC), Legion of Merit with four OLC, Distinguished Flying Cross with seven OLC, Soldier's Medal, Bronze Star Medal with "V" device and three OLC, Air Medal with 127 OLC, Army Commendation Medal with "V" device and two OLC, and the Purple Heart with three OLC.

BG OLENCHUK commands the U.S. Army Ammunition Procurement and Supply Agency, Joliet, Ill., and is also deputy CG and director of Procurement and Production, Army Munitions Command—titles he has held concurrently since February 1970.

His R&D assignments have included: deputy chief, Chemical-Biological Division, OCRD (1961-62); CO, U.S. Army Biological Center and Fort Detrick, Md. (1966-68); and chief of staff, U.S. Army Munitions Command (1968-70). He was a member of the Special Projects Branch, J-5, Organization of the Joint Chiefs of Staff (1964-66).

BG Olenchuk's academic credentials include a BS degree in chemistry and biology from Lebanon Valley College, an MS degree in bacteriology from the University of Wisconsin and a master's degree in business administration from George Washington University. He is also a graduate of the Army Command and General Staff College and the Industrial College of the Armed Forces.

He has been awarded the Legion of Merit with two OLC, Air Medal with OLC and the Joint Service Commendation Medal.

BG POWERS has served as CG of the 56th Artillery Group, U.S. Army, Europe, since September 1970.

He was CO, 2d Battalion, 44th Artillery and a member of a Special Study Group, Organization of the Joint Chiefs of Staff in 1962-63. Other key assignments have included: ballistic missile staff officer, Operations Division, Supreme Headquarters, Allied Forces, Europe (1965-67); CO, 56th Artillery Group, U.S. Army, Europe (1967-68); Joint Secretary, U.S. Military Assistance Command, Vietnam, deputy C/S, U.S. Army, Vietnam and chief of staff, I Field Force, Vietnam (1968-70).

BG Powers has a BS degree from the U.S. Military Academy and an MS degree in guided missiles from the University of Southern California. He has graduated from the Army Command and General Staff College and the U.S. Naval War College.

His awards include the Legion of Merit with two OLC, Distinguished Flying Cross, Bronze Star Medal, Air Medal, Joint Service Commendation Medal and the Army Commendation Medal with OLC.

BG SALTER has served as Director of Developments, OCRD, Washington, D.C., since November 1971. His R&D assignments have included staff officer, Missiles Division, OCRD (1961-63); chief, Ballistic Missile Branch, Missile Division, OCRD (1963-64); and staff officer, Air Defense and Missile Division, OCRD (1964-65).

He has also served as CO, 4th Missile Battalion, 57th Artillery, U.S. Army, Europe (1965-67); Requirements and Development Division, J-5, Office of the Joint Chiefs of Staff (1968-70); and from July 1970 to No-

Secretary of the Army Fellowships Awarded To Dr. Wolfe of WRAIR, Howard Jones of HDL

Mechanisms of drug action and resultant changes in intracellular physiology will be investigated by Dr. Alan D. Wolfe, and Howard S. Jones Jr. will pursue advanced microwave research under recently awarded Secretary of the Army R&D Fellowships.

SARS Fellowships provide for a full year of study and research by scientists, engineers and other researchers selected for their high potential for results profitable to the Army research and development program in areas of prime interest.

Recipients receive their full normal salaries and are paid all expenses during their research programs either in the U.S. or foreign nations.

Nominated by Walter Reed Army Institute of Research, where he is a research chemist with 14 years of Federal Civil Service, Dr. Wolfe commenced his studies in August at the Institut de Biologie Physico-Chimique in Paris, France. The latter part of his research will be at the Centre de Etudes nucleaire, Gie-Sur-Yvette, France.

Proposed for the study by Dr. Fred E. Hahn, his supervisor, Dr. Wolfe has distinguished himself as author or coauthor with Dr. Hahn and others of 26 publications in professional journals or major scientific symposia proceedings. Dr. Hahn recently shared with Miss Jennie Ciak of WRAIR a second-place $500 award for technical papers at the 1972 Army Science Conference.

Studies of the mechanism of drug action have been of intense interest at WRAIR for many years but particularly since drugs were developed, after exhaustive investigations and screening processes, to combat malaria in Southeast Asia. Some parasites later acquired an immunity to certain drugs.

Similarly, the U.S. Army's current widespread program to treat, rehabilitate and educate servicemen addicted to the use of harmful drugs has brought into sharp focus the need for greatly improved knowledge of general physiological changes that occur. Dr. Wolfe will thus be performing research of important significance.

HOWARD S. JONES is a GS-15 chief of the Microwave Research and Research and Development Branch at the Army's Harry Diamond Laboratories, Washington, D.C.

Employed for the first seven years of his Federal Civil Service career with the National Bureau of Standards as an electronics physicist, he was transferred to HDL when it was established in 1953 with a nucleus of about 150 selected NBS personnel.

In the endorsement of his proposed study by HDL Technical Director Billy M. Horton, Jones is described as an "extremely prolific employe throughout his career . . . (who) has made significant contributions to the microwave art . . . has achieved recognition as an authority in his field. He frequently serves as an expert adviser or consultant to other U.S. Government agencies and industrial organizations."

His SARS program provides for advanced research "directed toward advancing new techniques and the creation of new antenna designs for missile and weapon applications . . . development and design work on a class of dielectric-loaded antennas for use on conformal surfaces of missiles and projectiles. . . ."

Jones will study at Bucknell University, Lewisburg, Pa., and will avail himself of opportunities for observation and research at the nearby laboratories of RCA, Bell Telephone, General Electric Co., and Brooklyn Polytechnic Institute.

Dr. Alan D. Wolfe

Howard S. Jones

vember 1971 as CO, 31st Artillery Brigade, Homestead Air Force Base, Fla.

He is a graduate of the U.S. Military Academy with a BS degree, the University of Southern California with an MS degree in guided missiles, the Army Command and General Staff College, and the Industrial College of the Armed Forces.

His medals and awards include the Legion of Merit with two OLC and the Meritorious Service Medal.

BG TACKABERRY has served since June 1970 as deputy director for Reserve Officers Training Corps Affairs, Directorate of Individual Training, Office, Deputy Chief of Staff for Personnel. He was a staff officer and (later) chief, Human Factors Engineering Branch, Human Factors Division, Army Research Office, OCRD (1961–63); and staff officer, Allied Forces, Southern Europe (1964–65).

Other key assignments have included: CO, 2d Battalion, 8th Cavalry, 1st Division, Vietnam (1966–67); deputy director, Legislative Liaison, Office of the Assistant Secretary of Defense (1967–68); military assistant, Office of the Under Secretary of the Army (1968–69); CO, 196th Infantry Brigade, U.S. Army, Vietnam, and then chief of staff, HQ, America Division, Vietnam (1969–70).

BG Tackaberry has a BA degree in liberal arts from Gonzaga University and two MS degrees—in psychology from Tulane University and in international affairs from George Washington University. He is a graduate of the Army Command and General Staff College, U.S. Army War College and the Italian Army War College.

His medals and awards include the Distinguished Service Cross with two OLC, Silver Star with four OLC, Legion of Merit with two OLC, Distinguished Flying Cross, Soldier's Medal, Bronze Star Medal with two OLC, Air Medal with "V" device (53 Awards), Joint Service Commendation Medal, Army Commendation Medal with OLC and the Purple Heart.

BG VINSON is director, Plans and Programs and deputy chief of Research and Development for International Programs, OCRD.

In R&D assignments, he has served as a staff officer, Zeus Office and (later) chief, Nike-X Branch and (later) staff officer, Antiballistic Missile Office, OCRD (1962–65); chief, Nike-X and Space Division, OCRD; and director of Missiles and Space, OCRD (1967–68).

Other key assignments have included: CO, 2d Battalion, 19th Artillery, (later) deputy commander, Division Artillery, 1st Cavalry Division (Airmobile), U.S. Army, Vietnam (1966–67); CO, Division Artillery, HQ and HQ Battery, 2d Armored Division Artillery, Fort Hood, Tex. (1968–70); and CG, I Corps (Group) Artillery, Eighth U.S. Army (1970–71).

BG Vinson has a BS degree from the U.S. Military Academy and an MS degree in mechanical engineering from the University of Southern California. He is a graduate of the Army Command and General Staff College and the National War College.

His military honors include the Silver Star, Legion of Merit with three OLC, Bronze Star Medal with OLC, Meritorious Service Medal, Air Medal with six OLC and the Army Commendation Medal.

CERL Looks to Use of Industrialized Building

Speeding up construction of U.S. military facilities through use of the industrial building industry is one objective of a study underway at the Construction Engineering Research Laboratory (CERL), Champaign, Ill.

While use of industrialized building may have no immediate cost-saving advantages, it will cut construction time considerably. For example, a facility which would normally require one year to construct conventionally could be produced in four months. (Savings in money are expected to accrue with time.)

The program focuses on six basic building types: enlisted men's barracks, bachelor officers' quarters (BOQ), administrative buildings, warehouses, tank and automotive maintenance facilities, and classroom-type training facilities.

To enable District engineers to take full advantage of opportunities to use industrialized building, CERL's Special Projects Division (SPD) is preparing an interim report for guidance on standards, procurement procedures, cost-estimating procedures and "follow-on" evaluation.

Nearing completion is another aid to District engineers: a computerized data bank which can provide a specific project with quick information about feasible industrialized building firms in its geographic area. The information is stored at CERL for use by all CONUS Districts.

Information from an initial report published last year is already being put to use at Fort Knox, Ky., where Baltimore District is constructing a BOQ using industrialized building. This initial report identified available types of building systems and manufacturers.

DSMS Offers Program Management Courses

Supporting the Department of Defense goal of improving the Defense acquisition process through proper program management, the Defense Systems Management School (DSMS) has been offering numerous courses in this field since it was established on July 1, 1971.

The DSMS provides both long and short courses in effective program management for selected military and civilian personnel. Disestablished in June 1971 after operating more than seven years and graduating 1,500 students at Wright-Patterson Air Force Base, Ohio, the Defense Weapon System Management Center was succeeded the following month by the new DSMS located at Fort Belvoir, Va.

A 20-week Program Management Course covers in its core program such subjects as: Introduction to the Weapon Acquisition Process, Systems/Quantitative Analysis, Contract Management, and Industry Project Manager Case Studies.

Under the elective segment of this course, the syllabus takes in Financial Management, Management Information Systems, Advanced Interpersonnel Relations, and others.

DSMS assigns a quota of 20 military and civilian students to each Military Department (in addition to a number of civilian students assigned to Defense industry).

DSMS also offers a 3-week Executive Refresher Course in Program Management which reviews effective concepts and methods of program management. This course also examines new developments that have important implications for program managers.

A course in Cost/Schedule Control Systems Criteria (C-SCSC) will be offered for the first time in October and quarterly thereafter. This course is taught in two concurrent sections—a 5-day section for functional managers and a 2½-day section for program managers.

Augmenting the resident instruction is a guest speaker program which features managers and practitioners from the Department of Defense and the Military Departments, agencies of the U.S. Government, educational institutions, and defense industries.

To maintain a tri-Service balance within the staff, the DoD directive establishing DSMS calls for rotation of the commandant position among the Military Departments in the rank of brigadier general or rear admiral.

BG Winfield S. Scott, USA, has been the DSMS commandant since it was established. Deputy commandant and secretary is COL Levin W. Parker, USAF. Director of the Resident School is CPT John R. Johnson, USN, and William G. Gicking, a civilian, is registrar.

Students consist mainly of DoD personnel who occupy, or have been selected for, intermediate management positions in program offices, functional offices supporting them, or higher-echelon offices supervising program management.

Eligible to attend are: lieutenant colonels and majors from the Army, Air Force, and Marine Corps; commanders and lieutenant commanders from the Navy; and civilians in the grades of GS-12 and -13 from all the services.

ADP Interns Begin Training In USACSC-Sponsored Program

Nineteen Automatic Data Processing (ADP) interns, selected from more than 300 civilian applicants, have begun a 2-year training program sponsored by the U.S. Army Computer Systems Command (USACSC).

Selected on the basis of ADP aptitude test scores, motivation, experience and education, each student entered the program at the GS-5 grade level. In phase one, they will spend the first 26 weeks in video tape-assisted classroom work, including 20-day workshops in both assembler language coding and COBOL (Common Business Oriented Language).

When the training is completed, the interns will be promoted to GS-7. Phase two requires 18 months on-the-job training in technical and systems management commensurate with their individual backgrounds in the ADP field.

After successfully completing the 24-month program, the interns will be advanced to the grade of GS-9 and assigned as full-time programers and systems analysts throughout USACSC.

Women in Army Science . . .

Women's Lib in Army Labs Long Predates Modern Movement

Women's Lib in Army Science, insofar as selection for challenging research assignments consistent with their capabilities is concerned, predates the current highly publicized movement by about 25 years, and has been richly rewarding in results.

The *Army Research and Development Newsmagazine's* revised format provides for regular sectional treatment of notable contributions to Army research and development by female civilian and military scientists. This section also will direct attention to women who are newcomers to Army R&D positions or who have been assigned to important or newsworthy projects in Army laboratories.

The U.S. Army Natick (Mass.) Laboratories and the Electronics Command Laboratories, Fort Monmouth, N.J., recently submitted reports on some of their female scientists, as follows:

Dr. Mary H. Mandels came to the Natick Laboratories in 1955 and has made some exceptional contributions as a research microbiologist, in the Food Microbiology Division, Food Laboratory.

She has been selected for a 1972 Army Research and Development Achievement Award for her key role on a 9-member team credited with an enzymatic process to convert cellulose, such as waste paper, into glucose food products or a clean-burning fuel (methane or alcohol). This accomplishment is recognized as having vast potential as a productive and profitable means of waste disposal and pollution abatement.

Dr. Mary Mandels, research microbiologist in the Food Laboratory, and her husband Dr. Gabriel Mandels, chief of the Life Sciences Division, Pioneering Research Laboratory, U.S. Army Natick Laboratories, view culture used in her research. Her work on cultures was a key factor in the 100 percent enzymatic conversion of cellulose to glucose sugar, other food products, and a clean-burning fuel (methane).

Dr. Mandels has a 1939 BS degree in botany and a 1947 doctorate in plant physiology, both from Cornell University. She has authored or coauthored 32 scientific articles and four chapters in books, including a technical paper that was presented at the June 1972 Army Science Conference.

Dr. Mandels was nominated in 1971 for the Federal Women's Award and is listed in *American Men of Science,* and *Who's Who in American Women.* She is a member of the American Institute of Biological Sciences, Botanical Society of America, Institute of Food Technologists, and the Research Society of America.

Mrs. Mary V. Klicka is a ration design specialist in Natick's Food Laboratory where she performs advisory and coordination services on problems associated with operational rations. She is primarily concerned with development and design of packaged operational rations, special food packets and space feeding systems.

The high caliber of her work as an Army Scientist for 21 years has been recognized by such honors as the Army Meritorious Civilian Service Award (1966), the Army Decoration for Exceptional Civilian Service (1968), and the Department of Defense Distinguished Civilian Service Award (1970), in addition to many other awards.

Mrs. Mary V. Klicka

Mrs. Klicka graduated from the University of Washington in 1944 with a BS degree in dietetics and from the University of Chicago in 1947 with an MS degree in business administration. She has authored 25 technical papers published in professional journals.

Mrs. Margaret G. Driver

Mrs. Margaret G. Driver is a research chemist in Natick's Food Chemistry Division, specializing in food stability and preservation activities.

She holds a BS degree in pharmacy from Purdue University, has earned graduate credits at Amherst College, and has been selected to attend the University of Massachusetts for graduate studies under a Department of the Army training program.

A government employe for 26 years, Mrs. Driver has self-financed many of her evening courses in chemistry, physics and statistics.

Dr. Edith Tebo heads the Laser Techniques Team in the Electronics Command Electro-Optics Technical Area Combat Surveillance and Target Acquisition Laboratory. The team studies Army applications for the laser, such as range finders, illuminators, and optical radar systems.

She has an AB degree in astronomy, mathematics and physics from Vassar College, has done post graduate work at the University of Chicago, and earned her PhD in astrophysics from the University of Virginia. She was also awarded a post-doctoral fellowship at Harvard University, has authored 18 published technical papers, and is listed in *American Men of Science.*

Dr. Edith Tebo

Marilyn Levy, a 1971 recipient of the Army's Meritorious Civilian Service Award, is a chemist in the Photo-Optics Technical Area, Electronics Command Surveillance and Target Acquisition Laboratory. She has received international acclaim as a pioneer and as an expert in photographic research.

Her current work involves research in high-speed photographic processing, black and white, and color; dry photographic techniques; and photography for aerial surveillance.

She has been issued 15 patents and has nine pending as a result of her research into light-sensitive materials, photographic chemistry and image microstructure. Graduated from Hunter College with a BA degree in chemistry, she has done graduate work at Polytechnic Institute of Brooklyn.

Marilyn Levy

Mary Purvis is an electronics engineer with the 6-member Acquisition and Analysis Team of the Aircraft Installation and Test Technical Area, Electronics Command Avionics Laboratory. She is involved in developing improved methods for acquiring system data on Army aircraft avionics systems using newly developed electronic testing techniques.

The team designs and assembles data acquisition systems aimed at acquiring a high volume of data on avionics equipment installed in aircraft systems.

Miss Purvis has a BS degree in electrical engineering from Newark (N.J.) College of

Mary Purvis

Engineering, has completed most of the requirements for licensing as an aircraft pilot, and has spent three months in Vietnam with the ECOM Research and Development Liaison Team.

Mary Tate is an Electronics Command mathematician and a member of the Mathematics Support Branch of the Computer-Aided Design Engineering and Mathematics Support Division. She does research in numerical analysis and digital computer programing to develop computer methods applicable in ECOM research and development projects. Results are made available to other Army and Department of Defense agencies.

Mrs. Tate received a BS degree in mathematics, magna cum laude, from North Carolina College, Durham, N.C. She has done graduate work at Rutgers University and Fairleigh Dickinson University. She is a member of Beta Kappa Chi, national scientific honor society, and Alpha Kappa Mu, national honor society.

Mrs. Mary Tate

Audrey Becker is a patent draftsman in the Patent Division of the Electronics Command Legal Office. She works closely with scientists and lawyers, developing invention disclosure details from rough sketches and prepares formal patent application drawings for new types of equipment, devices and techniques in the mechanical, electrical, electronic, chemical, and photographic fields of research and development. Her work must comply with the standards of the U.S. Patent Office and are published in the Patent Office Gazette.

Audrey Becker

Army Wants Journalism Grads For 27 New Information Slots

Identifying 27 new information or broadcast officer positions Armywide, the 1972 Army Educational Requirements Board has called for candidates holding graduate degrees in journalism. The 27 new positions will increase to 139 the validated spots in the program.

Interested officers without a master's degree may receive the required schooling as members of the Information Officer Program, which they may join by writing their career branches. Application procedures are outlined in AR 614-140.

An applicant must be in the grade of captain through colonel in a branch other than medical, chaplain or the judge advocate general and should have a bachelor's degree, preferably in an information-related field.

Two MECOM Employees Win High-Level Awards

Two employes of the U.S. Army Mobility Equipment Command (MECOM), St. Louis, Mo., were recently presented high level awards by COL F. L. Worthington, MECOM deputy commander.

George V. Johnson received a Department of the Army Management Improvement Award and Robert W. Steele was awarded the 1972 Freedoms Foundation Medal of Honor.

Johnson was cited for development of two management tools credited with validated savings to the U.S. Government of $5.42 million. Chief of the Cost Analysis Division, Office of the Comptroller, he used more than 600 hours of off-duty time, working on his own initiative, to develop, prove and implement two management techniques based on a log-linear S-curve model.

One measures the cost of making design changes to a product that is in production, and the second predicts the production costs for an item that is in research and development.

Steele is chief of the Plans and Administrative Office of the Comptroller. He was selected a winner in the annual Freedoms Foundation essay contest on "What Is An American?"

An excerpt of Steele's essay in rhyme reads: "As the pages of history unfold/Here stands the American, God-fearing and bold/ Promoter, defender of a race built on pride/ He's the key to all mankind, may God be his guide."

Steele's previous Freedoms Foundation awards, for the years 1955, '56 and '57, gave him the singular distinction of being the only person who had won the award three consecutive times.

Kirwan Chosen AMC Director Of Training, Force Development

BG Robert L. Kirwan, who recently completed a 3-year tour as assistant commander, 3d Armored Division, U.S. Army, Europe, has assumed duties as director of personnel, training and force development, HQ U.S. Army Materiel Command, Washington, D.C. This position gives him responsibilities involving about 130,000 civilian and 14,000 military personnel.

His assignments in recent years have included: chief, Plans and Operations Division, Office, Deputy Chief of Staff for Personnel, U.S. Army, Europe and Seventh Army; assistant chief of staff, G-3 and CO, 1st Brigade, 4th Infantry Division, Vietnam; and Office of Personnel Operations, Department of the Army.

BG Kirwan is a 1948 graduate of the U.S. Military Academy (USMA) at West Point, N.Y., and of the Army War College in 1968. Among his awards and decorations are the Silver Star, Distinguished Flying Cross, Bronze Star Medal, Air Medal with "V" device (10 awards) and the Combat Infantry man Badge.

Personnel Actions . . .

OCRD Announces New Chiefs of Divisions, Other Assignments

AMC Picks COL Fix as Successor to BG Gates

COL (BG designee) Joseph Edward Fix III has succeeded retired BG Marlin E. Gates as deputy director of Research, Development and Engineering, HQ U.S. Army Materiel Command (AMC), Washington, D.C.

Prior to his new assignment he was CO, Detachment 1, Joint Task Force 728 of the Defense Special Projects Group, following 1969–71 duty as chief of the DSPG Operations Division.

COL Fix was executive secretary, Army Scientific Advisory Panel, Office of the Chief of Research and Development (OCRD) (1966–68); staff officer, Combat Materiel Division, OCRD (1965–66); CO, 1st Battalion, 4th Infantry Division, Europe (1963–64); and air reconnaissance officer, Targets Branch, G-2, HQ Central Army Group, Europe (1961–64).

COL Fix has a bachelor's degree from the University of Omaha, a master's degree in international affairs from George Washington University and is a graduate of the Air War College, Armed Forces Staff College and the Army Command and General Staff College.

His military decorations include the Silver Star with Oak Leaf Cluster, Legion of Merit with OLC, Bronze Star Medal, Air Medal (seven awards), Army Commendation Medal with two OLC and the Combat Infantryman Badge (second ward).

COL Joseph E. Fix III

ECOM Assigns Cheney as Procurement Director

COL (BG designate) Robert A. Cheney has succeeded BG James M. Templeman as director of Procurement and Production, U.S. Army Electronics Command (ECOM), Fort Monmouth, N.J. BG Templeman is ECOM's new deputy CG.

COL Cheney graduated from the U.S. Military Academy in 1946 and for the past two years was CO of Tobyhanna Army Depot, Pa.

From 1959 until 1962, he served in Germany at Mannheim and Pirmasens, after which he was assigned to the U.S. Military Academy until 1967 with Company K, 2d Regiment, as adjutant and then as executive officer. He later commanded the 4th Regiment until his assignment to Vietnam where he commanded the 44th Signal Battalion and later was executive officer of the 160th Signal Group.

Upon his return to the United States he was stationed in Washington, D.C., in the Office of the Deputy Chief of Staff for Logistics, as chief of the Aviation, Missiles and Communications-Electronics Section, Production and Industrial Facilities Branch, PEMA Execution Division.

COL Robert A. Cheney

COL Cheney received an MBA degree from Harvard University in 1957, completed the Command and General Staff College in 1963, and in 1969–70 attended the Industrial College of the Armed Forces. Two years later he completed the management program for executives at the University of Pittsburgh.

COL Cheney's decorations include the Legion of Merit with Oak Leaf Cluster, Army Commendation Medal (with OLC), Vietnam Service Medal with four campaign stars, Korean Service Medal with seven campaign stars, and the Republic of Korea Presidential Citation.

Twenty-two officers and one civilian have recently reported for duty with the Office of the Chief of Research and Development (OCRD), Department of the Army, since the August edition of the *Army R&D Newsmagazine.*

COL James W. Barnett is chief of the recently established Science and Technology Division, following a tour of duty as district engineer, U.S. Army Engineer District, New York City, N.Y.

In 1968-69 he was chief, Plans and Operations Division, Construction Directorate, Headquarters, Military Advisory Command Vietnam (MACV). During 1966-68 he served as commanding officer, 7th Engineer Battalion, 5th Infantry Division, Fort Carson, Col., and as CO, 331st Eningeer Group.

In 1963-65 he was chief, Facilities Projects Office, George C. Marshall Space Flight Center, National Aeronautics and Space Administration (NASA), where he was instrumental in construction and development, production and test facilities for Saturn IB and Saturn V launch vehicles.

COL Barnett has a 1948 BS degree from the United States Military Academy (USMA), West Point, N.Y., and a 1956 MS degree in nuclear engineering from the Massachusetts Institute of Technology.

He was responsible for the construction of nuclear power plant at Camp Century, Greenland, and expansion of facilities for USMA. He is a graduate of the Army Command and General Staff College and the U.S. Army War College. *(Continued on page 41)*

ARDISO Chief Leaves 4-Year OCRD Tour for Korea

COL Robert E. Lazzell, chief of the Army R&D Information Systems Office, ended more than four years duty with the Office of the Chief of Research and Development in mid-August to become director of the Advanced Research Projects Agency Field Office in Korea.

The Office of the Director of Defense Research and Engineering assignment makes COL Lazzell responsible directly to ARPA Director Dr. Stephen J. Lukasic, whose headquarters is in the Architects Building, Arlington, Va.

Prior to assignment as chief of ARDISO in June 1971, COL Lazzell had been assigned to the OCRD Plans Division since July 1968. He was chief of the Mid-Range Plans Branch, then headed the Long-Range Plans Branch, and was elevated to division chief in February 1970.

ARPA's mission in Korea, in the broadest sense, is to work with U.S. Department of Defense commanders in the field to relate ARPA programs to their problems. The emphasis is on collecting information that will influence ARPA R&D efforts in their formulative stage. Attention is devoted also to Republic of Korea problems that are related to those of the U.S. forces.

Established Dec. 30, 1959, under provisions of the National Security Act of 1947 as amended, including the Department of Defense Reorganization Act of 1958, ARPA is responsible for basic and applied R&D for such advanced projects as the Director of Defense Research and Engineering assigns.

ARPA arranged for the performance of and supervised the work connected with advanced projects of the Military Departments, other U.S. Government agencies, individuals, private business entities or educational or research institutions. Consideration is given to the primary functions of the Military Departments.

ARPA is charged with keeping the Director of Defense Research and Engineering, the Joint Chiefs of Staff, the Military Departments, and other defense agencies as appropriate, informed on significant new developments, breakthroughs and technological advances within assigned projects. This includes status reports on projects to facilitate early operational assignments.

COL Robert E. Lazzell

(Continued from page 40)

His military decorations include the Legion of Merit (LM) with Oak Leaf Cluster (OLC) and the Army Commendation Medal (ARCOM) with two OLC.

COL William E. Crouch Jr. is chief, Air Mobility Division, following assignments (1971-72) as deputy commander, Operations, 3d Brigade, 1st Cavalry Division, Vietnam; G-3 1st Aviation Brigade, Vietnam and as commanding officer, 101st Aviation Group, 101st Airborne Division.

In 1969-70 he was commanding officer, 9th Aviation Battalion and then executive officer, 17th Aviation Group, Vietnam. During 1967-68 he served as chief, Flight Test Engineering Division and later as deputy commander, U.S. Army Aviation Test Activity.

COL Crouch received a 1951 BS degree from the USMA and a 1959 MS degree in aeronautical engineering from Mississippi State University. He has graduated from the Army War College and the Army Command and General Staff College.

Among his military honors are the LM with OLC, Distinguished Flying Cross (DFC) with OLC and the Bronze Star Medal (BSM) with "V" device and four OLC.

COL Robert O. Viterna is the new chief of the Behavioral Sciences Division. In 1971-72 he was G-3, 101st Airborne Division at Fort Campbell, Ky., after serving as the inspector general, 1st Armored Division, Fort Hood, Tex., and later the IV Corps adviser, MACV.

During 1968-69 he served as battalion commander, 4th Battalion, 46th Infantry, Fort Hood, Tex., and in 1966-67 was a staff officer, Personnel and Administrative Division, Allied Forces, Central Europe.

COL Viterna has a 1950 BS degree in psychology from Northwestern University and a 1965 MS degree in behavioral science from the University of Wisconsin. He is a graduate of the Army Command and General Staff College.

His military honors include the LM with OLC, BSM, Meritorious Service Medal (MSM), Air Medal (AM) with OLC, ARCOM with OLC and the Purple Heart.

LTC Bernard W. Bruns is a staff officer with the Test and Evaluation Branch, Management and Test Division.

From 1969-72 he was engineer standardization representative, U.S. Army Standardization Group, United Kingdom. In 1968-69 he served first as battalion commander, 212th Aviation Battalion and (later) as project officer, Army Concept Team, Vietnam. He was chief, Training Branch, Director of Instructions (1966-68) at the U.S. Army Aviation School, Fort Rucker, Ala.

LTC Bruns received a 1953 BS degree in agricultural engineering from Texas A&M University and a 1959 MS degree in civil engineering from Iowa State College. He also is a graduate from the Army Command and General Staff College.

His military awards include the LM, AM and ARCOM.

LTC John L. Cannon is program team chief, Programs Division, following 1971-72 assignments as deputy engineer, U.S. Army Vietnam, and as chief, Plans Division, Facilities Engineering Directorate, Vietnam. He was executive, Military Construction Directorate, Office, Chief of Engineers, in 1969-71, following a 3-year tour as deputy engineer, U.S. Army Support, Thailand, and (later) as CO, 17th Engineer Battalion, 2d Armored Division, Fort Hood, Tex.

LTC Cannon has a 1952 BS degree from USMA and a 1957 MS degree in civil engineering from California Institute of Technology. A graduate of the Army Command and General Staff College, he has been awarded the LM with OLC and ARCOM with OLC.

LTC Sammy J. Cannon is chief, Electronic Warfare and Space Branch, Command Systems Division.

From 1969-72 he was R&D coordinator and later chief, Technical Analysis Division, Materiel Test Directorate, Modern Army Selected Systems, Test Evaluation and Review, Fort Hood, Tex. In 1968-69 he served first as combat surveillance officer, HQ U.S. Army, Vietnam and later as battalion commander, 369th Signal Battalion, Vietnam. He was senior aide to the U.S. Permanent Military Representative, Central Treaty Organization in 1965-67.

LTC Cannon has a 1952 BA degree in engineering and business from Texas A&M University and a 1962 MA degree in Middle East studies from Princeton. He has graduated from the Army Command and General Staff College.

Among his military honors are the LM, BSM, AM, Joint Service Commendation Medal (JSCM) and ARCOM.

LTC William J. Fiorentino is a staff officer with the Management and Analysis Branch, Management and Test Division.

In 1968-69 he was a logistics adviser, assigned to the Training Directorate, MACV and from 1966-68 was a project officer with the Advanced Research Projects Agency, Office Secretary of Defense, Thailand. He was project coordinator, Office Project Manager, Nike Zeus and Nike X at Redstone Arsenal and Kwajalein Island in 1960-66.

LTC Fiorentino received a 1956 BS degree in physics from Fordham University and a 1961 MS degree in engineering from the University of Alabama. He has attended the Army Command and General Staff College.

He has authored "Selecting Team Leaders," *USAF Instructors Journal,* and "Numerical Cost Effectiveness Guidelines for Project Managers," *Military Review* (pending publication date).

(Continued on page 42)

CRREL Appoints Freitag as Technical Director

Dr. D. R. Freitag, newly appointed technical director of the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, N.H., was for 20 years the assistant technical director of the Waterways Experiment Station (WES), U.S. Army Corps of Engineers, Vicksburg, Miss.

COL J. F. Castro, commanding officer and director, announced that Dr. Freitag will provide leadership of the CRREL scientific and engineering research and development program.

CRREL is engaged in research on snow, ice and frozen ground problems linked to military operations, including engineering and construction in cold climates. CRREL also is participating in studies of preservation and enhancement of the cold regions environment.

Dr. Freitag received a bachelor's degree in civil engineering from Iowa State University in 1949, a master's degree at Harvard University and PhD at Auburn University. He was the recipient of a Secretary of the Army Research and Study Fellowship in 1961.

A founding member of the International Society for Terrain-Vehicle Systems, and a member of the American Society of Civil Engineers and the American Society of Agricultural Engineers, he is also associate editor of the *Journal of Terra Mechanics.*

Dr. D. R. Freitag

Ambrose Heads TECOM Infantry Materiel Tests

COL Bernard J. Ambrose

COL Bernard J. Ambrose, a recent graduate of the U.S. Army War College, is the new director of the Infantry Materiel Testing Directorate, HQ U.S. Army Test and Evaluation Command (TECOM), Aberdeen (Md.) Proving Ground.

In 1970–71 he was deputy assistant chief of staff, G3, HQ U.S. Army Alaska. From 1965 to 1969, he served in the Office of the Joint Chiefs of Staff, Washington, D.C., and then with the Army Element of the Alternate Military Command Center, Fort Ritchie, Md.

Upon graduating in 1963 from the U.S. Army Command and General Staff College at Fort Leavenworth, Kans., COL Ambrose was given special training in Vietnam-type warfare and then spent 1964 as a field adviser in the strategic hamlet program with the Military Assistance Advisory Group in Vietnam.

In 1960 he was named assistant secretary of the general staff at the Presidio of San Francisco, following duty as assistant professor of military science, University of California.

COL Ambrose began his Army career in the Asiatic-Pacific Theater in World War II. He received his Infantry commission in 1950 as a Distinguished Military Graduate of the University of Dayton, Ohio, and served in seven campaigns in Korea. Then, after 18 months at Fort Benning, he was stationed for three years in Germany.

His awards and decorations include the Legion of Merit with Oak Leaf Cluster, the Bronze Star Medal, the Joint Service Commendation Medal, the Combat Infantryman Badge, the Joint Chiefs of Staff Identification Badge, the Army Presidential Unit Citation, Marine Presidential Unit Citation (two awards), and Distinguished Unit Citation.

OCRD Announces Personnel Assignments

(Continued from page 41)

His military honors include the BSM, JSCM with two OLC and ARCOM with OLC.

LTC Clyde E. Goodyear is a staff officer with the Missiles and Special Weapons Division after serving as commander of the 3d Battalion, 7th Air Defense Artillery, U.S. Army Europe.

From 1967-69 he was chief, Forward Area Weapons Division, U.S. Army Air Defense School, Fort Bliss, Tex. and in 1967 was S-3, 1st Battalion, 44th Artillery, Vietnam, after a 3-year assignment as gun test officer, Air Defense Board, Fort Bliss, Tex.

LTC Goodyear has a 1955 BA degree from LaSalle College and is a graduate of the Armed Forces Staff College. His military awards include the BSM, MSM and ARCOM.

LTC Hubert W. Lacquement is a staff officer with the Combat Materiel Division, following his assignment as branch chief, Operations Branch, Policy and Operations Division, Director of Logistics, MACV.

During 1968-71 he was executive officer, Research and Development Directorate, HQ U.S. Army Weapons Command and was acting project manager for artillery ammunition, Army Materiel Command in 1967.

LTC Lacquement has a 1953 BS degree from the USMA, an MS degree in metallurgy from Stevens Institute of Technology in 1960, and is a graduate from the Army Command and General Staff College. Among his military honors are the MSM, JSCM and ARCOM.

LTC Ronald J. Lemanski is a staff officer with the Command Systems Division, after serving as project officer, Office of Space Systems, Office of the Secretary of the Air Force in 1970-71, and battalion commander, later S-4, II Field Force Artillery, Vietnam in 1969-70.

During 1966-69 he served as R&D officer, Defense Communications, Planning Group, and in 1965-66 as deputy chief, Engineering Division, TOW Weapons Systems.

LTC Lemanski earned a BS degree in 1954 from the U.S. Military Academy and an MS degree in aerospace engineering from the University of Arizona in 1965. He is a graduate of the Army Command and General Staff College and the Industrial College of the Armed Forces.

He has been awarded the LM, DFC, BSM with "V" device and two OLC, MSM, AM (four awards), and ARCOM with OLC.

LTC Eugene S. Lynch is a staff officer with the Operations Office, U.S. Army Advanced Ballistic Missile Defense Agency (ABMDA).

During 1970-71 he served first as S-3 and later as assistant fire support coordinator, 23d Artillery Group, Vietnam. He was an assistant professor, Department of Mathematics, USMA (1967-69).

LTC Lynch holds a 1956 BS degree from the USMA and a 1967 MS degree in mathematics from Rensselaer Polytechnic Institute. He is also a graduate of the Army Command and General Staff College.

His military honors include the BSM with OLC, AM and ARCOM with OLC.

LTC Anthony J. Ortner, who graduated in 1972 with a MS degree in aerospace engineering from the Georgia Institute of Technology, is a staff officer with the Air Mobility Division. In 1969 he commanded the 221st Aviation Company, 13th Combat Aviation Battalion, U.S. Army Pacific, Vietnam.

From 1968-69 he served as adjutant, HQ and HQ Detachment, 13th Aviation Battalion, Vietnam and was assistant branch chief and later flight commander, Tactical Branch 2, Department Rotary Wing, in 1966-68. He was troop executive officer, 9th Cavalry Squadron, 1st Cavalry Division, Vietnam in 1966.

A 1956 graduate of USMA, he has a 1968 MS degree in aerospace operations management from the University of Southern California and is also a graduate from the Air Command and Staff College. His publications include "Sonic Boom: Containment or Confrontation," *Journal of Air Law and Commerce,* School of Law, Southern Methodist University.

Among his military honors are the BSM and AM with seven OLC.

LTC Allen G. Truby is newly assigned as a staff officer with the Electronics Warfare Branch, Command Systems Division.

During 1969-70 he was chief, Avionics Division, Logistics Branch, Aviation Section, Vietnam and in 1966-68 was director, Avionics Department, U.S. Army Southeastern Signal School, Fort Gordon, Ga. In 1965-66 he was head of the Consolidated Avionics Repair Detachment in the 765th Transportation Battalion, Vietnam.

LTC Truby has a 1965 BS degree in chemistry from Kent State University and a 1972 MS degree in aerospace engineering from the University of Arizona. He is a graduate of the Army Command and General Staff College.

His military awards include the BSM with OLC, AM with six OLC and ARCOM with OLC.

LTC James M. Turner Jr. has been assigned as nuclear weapons staff officer, Missiles and Special Weapons Division after serving as chief of the Special Operations Branch, Surface Operations Division, MACV.

His other assignments have included: chief of the Nuclear-Biological-Chemical (NBC) and Reports Division, HQ North American Air Defense Command, Colorado Springs, Colo.; G-3 executive plans officer, Chemical, Biological and Radiological Division, HQ Alaska; and combat developments staff officer, NBC Branch, Combat Operations Division, HQ U.S. Army Combat Developments Command.

LTC Turner has a 1952 BS degree in chemistry from Louisiana State University, a 1957 master's degree in physics from the U.S. Naval Post-graduate School, and is a graduate of the Army Command and General Staff College. He is a recipient of the LM and OLC, the JSCM, and ARCOM with two OLC.

LTC Thomas E. Williams, a new staff officer in the Combat Materiel Division, recently concluded a 3-year tour as research analyst in armor maintenance and later as special assistant to the Chief of the Materiel Division, U.S. Army Combat Developments Command Maintenance Agency, Aberdeen (Md.) Proving Ground.

In 1968-69 he was assistant chief of staff, G-4, with the 25th Infantry Division, Vietnam, and during 1966-68 commanded the 3d Battalion, 1st Brigade, Fort Polk, La.

LTC Williams has a 1953 bachelor's degree from the USMA, a 1961 MS degree in mechanical engineering from the Georgia Institute of Technology, and has graduated from the Armed Forces Staff College. From 1961 to 1963 he designed and was instrumental in the building of a Land Locomotions Laboratory at the USMA for studies of the properties of soil dynamics. His publications include "Variable Compression Ratio—The Engine of Tomorrow," *Armor* magazine, 1966.

Among his military honors are the LM, BSM with OLC, AM and ARCOM.

MAJ Edward V. DeBoeser Jr. is a military assistant and nuclear program coordinator, U.S. Army Advanced Ballistic Missile Defense Agency. He recently completed a tour as research and development liaison officer with the Field Command Defense Nuclear Agency, Livermore, Calif.

In 1969-70 he was battalion S-3 with the 7th Battalion, 8th Artillery, and assistant G-3 II Field Force, Vietnam. During 1965-68 he was a physicist with the Field Command Defense Atomic Support Agency.

MAJ DeBoeser received a 1958 BS degree from the USMA and a 1965 MS degree in physics from Tulane University. He has graduated from the Army Command and General Staff College.

His military decorations include the BSM and ARCOM (2 OLC).

MAJ Leonard L. Friesz is chief, Program Management Office, U.S. Army Advanced Ballistic Missile Defense Agency, following a tour as chief, Systems Engineering Branch, U.S. Army Experimentation Command.

In 1968 he was logistics staff officer, J-4, MACV and during 1965-67 served as Nike-X operations officer, Kwajalein Test Site. He was research and development coordinator, U.S. Army Missile Command in 1964-65.

MAJ Friesz holds a BS degree and an MS degree in electrical engineering from the University of Missouri.

His military decorations include the BSM and ARCOM with two OLC.

MAJ Albert F. Gleim is assigned as a plans officer with the U.S. Advanced Ballistic Missile Defense Agency.

He has served as chief of the Site Control Office, Safeguard Site Activation Command, Grand Forks, N.D.; division ammunition officer, 9th Infantry Division, Vietnam; operations officer and later as commanding officer of the 4th Ordnance Company in Germany; and encoding officer, Permissive Action Link Detachment in Germany.

MAJ Gleim received a 1962 BS degree in mechanical engineering from the Massachusetts Institute of Technology and a 1970 MS degree in aeronautical engineering from Ohio State University. He is also a graduate of the Army Command and General Staff College.

Among his military honors are the BSM, MSM, AM and ARCOM.

MAJ Sammy K. Hull is newly assigned as assistant administrative officer with the Office of the Chief of Administration.

In 1969-70 he served as operations officer, I Field Force Artillery, Vietnam and later as battalion executive officer, 5th Battalion, 27th Artillery, Vietnam. He commanded the 6th Gun Battalion, 14th Artillery and was later administrative assistant with the Deputy Chief of Staff, Eighth Army (1965-66).

MAJ Hull has a 1958 BS degree in history from West Texas State University, a 1972 MA degree in international relations from the University of Arizona, and has graduated from the Army Command and General Staff College.

He has received the BSM with OLC, AM with two OLC and ARCOM with two OLC.

MAJ George C. Kopcsak, who has a 1972 MS degree in electrical engineering from the Georgia Institute of Technology, is a new staff officer with the Missiles and Special Weapons Division.

In 1969 he was S-3 in Vietnam with the 2d Battalion, 138th Artillery, and in 1968 was fire support coordinator with the XXIV Corps in Vietnam. During 1965–67 he served first as battery commander and later as assistant S-3 with the 1st Battalion, 81st Artillery, Germany.

MAJ Kopcsak earned a 1961 BS degree from the USMA and is a graduate from the Army Command and General Staff College.

His honors include the BSM, AM with "V" device and ARCOM with OLC.

MAJ Vernelle T. Smith is a staff officer with the Environmental Sciences Division following a 1969–71 tour as special item manager for the Family of Military Engineer Construction Equipment (FAMECE), Mobility Equipment R&D Command.

During 1968–69 he was S-3, 15th Engineer Battalion (combat) and assistant G-3, 9th Infantry Division, Vietnam. He also served as a research analyst, Evaluation Division, Combat Developments Command (1967–68) and company commander, 864th Engineer Battalion, Vietnam (1966–67).

MAJ Smith has a 1959 BS degree in civil engineering from Michigan Technological University, a 1966 MS degree in civil engineering from the University of Missouri at Rolla, and is a 1972 graduate of the Army Command and General Staff College.

He is coauthor of "Integrated Logistics Support for FAMECE," which appears in the Sept.-Oct. 1971 issue of the *Army Logistician.* Among his military awards are the BSM with four OLC, MSM, AM and ARCOM.

MAJ Larry E. Word is newly assigned as staff scientist with the Army Motivation and Training Laboratory, Army Manpower Resources Research and Development Center.

During 1969–70 he was executive officer, Company D, 7th Special Forces Group and later an instructor/monitor with the Military Assistance School, Fort Bragg, N.C. In 1968–69 he was S-1, 1st Brigade, and later S-3 1st Battalion, 327th Infantry, 101st Airborne Div., Vietnam.

During 1967–68 he served first as chief of the Patrolling Committee, Mountain Ranger Camp at Dahlohega, Georgia, and later as executive officer, 502d Infantry, 101st Airborne Division, Vietnam.

MAJ Word has a 1962 BS degree in physical education from Kansas State University and a 1972 MS degree in social psychology from Florda State University. He is coauthor of "A Case Where the Bystander Did Help," *Eastern Psychological Association,* New York, 1971 and "Why Don't Bystanders Help? Because of Ambiguity?" in the forthcoming edition of the *Journal of Personality and Social Psychology.*

His decorations include the BSM with "V" device and three OLC, AM with five OLC and ARCOM with OLC.

Harvey L. Bleicher, a 1969 University of Maryland graduate with a BA degree in political science, has joined the *Army R&D Newsmagazine* staff as a writer (career intern). His previous assignment was with the Staff Civilian Personnel Division, Department of the Army.

In 1967–69 he served in the U.S. Navy. He is a recent graduate of the Defense Information School at Fort Benjamin Harrison, Ind.

COL Teague Assumes ARDISO Command

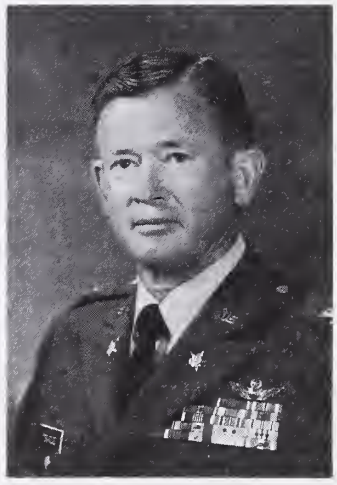
COL Jerry L. Teague assumed command of the U.S. Army Research and Development Information Systems Office (ARDISO) following graduation from the Industrial College of the Armed Forces (ICAF), Washington, D.C.

In 1969 he returned to Vietnam for a second tour of duty as CO of the 14th Combat Aviation Battalion of the Americal Division. He is a Master Army Aviator, qualified in fixed- and rotary-wing aircraft, with over 4,000 hours flying experience. During a 1965 tour in Vietnam he was engineer project officer with the Army Concept Team.

COL Teague was deputy commander of the Engineer Agency, U.S. Army Combat Developments Command, Fort Belvoir, Va., in 1970–71. Among other assignments, he served successively as S3, executive officer and CO of the 2d Engineer Battalion, 2d Infantry Division at Fort Benning, Ga.; Joint and Army Plans Officer, Plans Division, and later as assistant executive, Office of the Chief of R&D, HQ DA; and CO of two different engineer companies and aviation staff officer, 11th Engineer Group in Europe.

While assigned to the U.S. Military Academy, he commanded the 2d Aviation Detachment and was aviation staff adviser to the USMA superintendent.

COL Teague has a BS degree in mechanical engineering from Louisiana State University, an MS degree from George Washington University, and is a graduate from the Command and General Staff College, and the Armed Forces Staff College. His awards include the Legion of Merit, Distinguished Flying Cross, Bronze Star, Air Medal, Army Meritorious Service Medal, Army Commendation Medal, and Vietnamese Cross of Gallantry with Silver Star.



COL Jerry L. Teague

OTSG Announces 5 Key Personnel

Four officers and one civilian are among personnel newly assigned to the Office of the Surgeon General, U.S. Army.

COL (Dr.) Robert T. Cutting, MC, is a communicable disease consultant in the OTSG Directorate of Health and Environment, after serving as director of the Division of Surgery at Walter Reed Army Institute of Research, Washington, D.C.

Until recently he was head of the U.S. Army Medical Research Team in Vietnam, following an assignment as chief of the Preventive Medicine Research Division in the U.S. Army Medical Research and Development Command.

COL Cutting is a graduate of Holy Cross College with a master's degree in public health from Harvard and a doctorate in medicine from Boston University. He also attended the Army Command and General Staff College.

COL (Dr.) Richard L. Howard, DC, has succeeded COL William D. Love as deputy assistant surgeon general for Dental Services. His previous assignment was dental surgeon for the U.S. Army, Pacific.

COL Howard served two previous tours with the OTSG,, first as assistant chief, Dental Corps Branch, Personnel and Training Directorate and later as chief of the Preventive Dentistry Branch.

He graduated from the University of California at Berkeley, earning a BS degree, DDS and later an MS degree in public health. His military education includes the Command and General Staff College and the Army War College.

COL (Dr.) Richard H. Ross, MC, has resumed his position as director of Plans, Supply and Operations, following duty in Vietnam as head of the U.S. Army Medical Command and as staff surgeon.

Other key assignments have included vice chairman of the Army Medical Study Group, formed to consider changes in the Medical Department's worldwide organization; and chief, Personnel and Training Directorate, OTSG.

COL Ross has a BS degree from Seattle University, a medical degree from Jefferson Medical College, Philadelphia, and a master's degree in health care administration from Baylor University. He is a graduate of the Army Command and General Staff College and the Army War College.

LTC Raymond E. Smith, MC, has been assigned as chief, Personnel Services Division, after serving at Walter Reed Army Medical Center.

LTC Smith served earlier in OTSG as assistant chief, Personnel Services Division. In Vietnam he was executive officer with the 91st Evacuation Hospital. He also has served as chief, Plans and Training, Walson Army Hospital, Fort Dix, N.J.

Graduated from Temple University in Philadelphia with a bachelor's degree, he has a master's in hospital administration from Baylor University.

James L. Redwine has assumed duties as the new equal employment opportunity officer. He holds a bachelor's degree from Trinity University and a master's degree in education from Southwestern Seminary in Fort Worth, Tex., in addition to completing resident study for his doctorate in education at Southwestern in 1967.

Reader's Guide . . .

New Book Discusses Technology Transfer Ideas

Technology Transfer, a high-priority goal President Nixon has set in recent addresses to stimulate civilian use of military research and development advances, poses such questions as:

What technological advances are being produced by U.S. Government research and development programs? What agencies are producing what?

Where is the stockpile of U.S. Government R&D reports that contain commercially valuable nuggets of technology? How do you get at the reports you want—locally, quickly and at low cost?

How do you go about determining what would be a valuable new commercial product line? And how do you find the know-how for achieving it in the government R&D stockpile?

Technology Transfer: How to Make It Work is the title of a newly published 91-page management handbook that attempts to provide helpful answers to these and related questions.

Hyman Olken, the author, sent a copy for review by the editorial staff of the *Army Research and Development Newsmagazine*—influenced perhaps by recent feature articles carried on the President's appeals and the establishment of a Science and Technology Division as a major new element in the Office of the Chief of Research and Development.

"A valuable initial step in finding this 'primary source' of technological advances to your industry," Olken states, "is to read the periodicals put out by the different Government agencies, which report on the R&D work done by the respective agencies.

"The Air Force has one *(OAR Research Review)*; the Navy also has one *(Naval Research Reviews)*. A particularly good one is the Army's *(Army Research and Development Newsmagazine)*.

"One issue alone (Nov-Dec 1970) tells you that the Army's work in developing new metals and metal processes and equipment is concentrated in the U.S. Army Materials and Mechanics Research Center (AMMRC) at Watertown, Mass. It also tells you this center has contributed the following technological advances, which have obvious potential for commercial application:

1. A process for enhancing the strength-to-weight properties of titanium. 2. A non-destructive testing method for detecting and picturing flaws inside metals. 3. A new titanium-aluminum alloy that extends the range of application of titanium to higher temperatures in gas turbine engines. (Page citations are given for each of these articles.)

"One also learns, from another article in the same issue, that the Army has a technology center for advances in concrete construction in the U.S. Army Engineer Waterways Experiment Station at Vicksburg, Miss. At this center a major line of work that would be particularly valuable to civilian industry is R&D on low-density concretes, which would make these materials applicable for backfills for tunnels and pipelines; also for protection of reactor foundations for seismic instability.

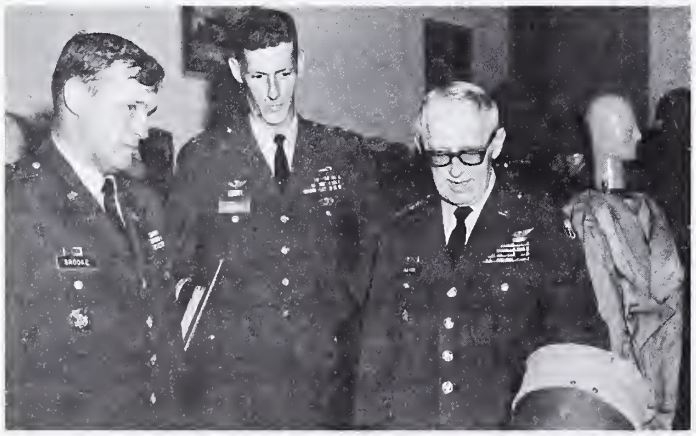
"Finally, one also learns, in the same issue, of extensive work in night-vision devices centered at the Army's Night Vision Laboratory at Fort Belvoir, Va., which work has led to commercially available advances in fiber optics and sensitive light-activated (photo-sensitive) cathodes."

The author discusses various other sources of R&D reports, such as the *Monthly Catalog of United States Government Publications*. He also discusses the role of the Defense Documentation Center, the National Technical Information Service, the NASA Scientific and Technical Information Facility, and the various Technical Information Analysis Centers supported by the Department of Defense.

Forty federal contract R&D laboratories also are listed, as are such institutions as the Applied Physics Laboratory of Johns Hopkins University, the Jet Propulsion Laboratory of the California Institute of Technology, the Lawrence Radiation Laboratory at Livermore, Calif., the Lincoln Laboratory of Massachusetts Institute of Technology, the Oak Ridge National Laboratory, and various other technology centers.

Graduated from Harvard University with BS and MS degrees in electronic engineering, author Olken states that he has "14 years of first-hand experience in the evolution of new technology and its conversion to profitable new commercial products (i.e., Technology Transfer)." He also has experience in technology transfer operations of the federal government through former employment in the Office of Technical Services.

Technology Transfer: How to Make It Work is available from Olken Publications, 2830 Kennedy Street, Livermore, Calif. 94550.



THE NEW ARMY CHEMICAL MUSEUM was dedicated recently at Fort McClellan, Ala., by MG John J. Hayes, shown looking at a Livens projector together with COL Stafford R. Brooke, U.S. Army Chemical Center and School commandant, and CPT Gary E. Harvey, escort officer. MG Hayes was the Army's senior chemical officer when he retired with 38 years service two days after the ceremony. A chemical museum was established in 1921 at Edgewood (Md.) Arsenal, but it was recently determined to relocate it at the "Home of the Chemical Corps."

Deseret Improving Document Indexing System

KWIC and KWOC are two relatively new terms to join the Deseret Test Center (DTC) vocabulary, denoting Key-word-in-context and Key-word-out-of-context. The acronyms are heard most frequently in the scientific and technical information library at Fort Douglas, Utah, where a large-scale improvement project for the indexing of documents is under way.

The library improvement project has been initiated to establish an accession indexing system for all documents in the DTC library. In excess of 35,000 documents are not accessioned under one system, and the library staff is working all-out to establish an all-inclusive subject-based indexing system within four months.

For the purposes of the indexing system, the term documents includes reports, pamphlets and all scientific and technical publications not included as books under the Dewey Decimal System.

Establishment of one system under which all documents are indexed is expected to increase greatly the availability of scientific and technical information. The first goal is to establish within four months a manual system under which all documents will be indexed by subject. A computerized accession system is the second goal. All publications will, as a minimum, be indexed by subject, title, and corporate author.

The route to the new library document retrieval system lies through KWIC and KWOC. All documents will be described on the index by keywords that define the particular subject area of the publication. The six or less keywords on the index will actually accommodate 480 letters. Thus, one "key word" could be an entire phrase. It is anticipated that the use of key words will significantly reduce the time the DTC researchers spend in conducting literature searches.

To meet the 4-month goal, the normal library staff of 11 has been augmented by the Plans and Studies Directorate with seven additional people. Combined with personnel working under the Summer Hire Program, the library staff currently numbers 28.

NBS Publishes Thermocouple Reference Tables

Reference Tables For Low-Temperature Thermocouples is the title of a recent publication issued by the National Bureau of Standards (NBS).

Identified as Monograph 124, this 61-page report makes available recently acquired data for low-temperature thermocouples.

Details of the cryostat, measurement scheme, error analysis, analytical representation of the experimental data, enable users to judge creditability of the data and to increase their understanding of the extent and limitations of the experiments.

Rapid expansion of cryogenic technology in the last 20 years created the need for standardized thermocouple calibrations in the cryogenic temperature range.

EPA Issues New Publication on Noise Facts

Noise Facts Digest, a new publication of the U.S. Environmental Protection Agency, was issued in August.

The EPA said that the journal was developed in response to a widely expressed need for more and better information on the prevention, abatement and control of noise. The first issue contains two general interest articles and some 200 abstracts of material selected from the domestic and foreign literature.

Contents of subsequent issues of *Noise Facts Digest* will reflect comments of readers to whom sample copies are being sent. Material in the first issue was selected for abstracting on the basis of its potential interest to a wide range of readers. The list included not only noise specialists but also state and local officials, planners, builders, highway engineers and others only indirectly concerned with noise.

Sample copies may be obtained by contacting: Chief of Technical Publications, Office of Noise Abatement and Control, U.S. Environmental Protection Agency, Washington, D.C. 20460.

Report Covers Electron Calculation Technique

A calculation technique suitable for batch reduction of data in quantitative electron probe micronanalysis, including all necessary practical details, is described in National Bureau of Standards Technical Note 719.

Issued in May, this 49-page document is titled "A Simple Correction Procedure for Quantitative Electron Probe Microanalysis." The technique is embodied in a computer program, called MULTI8, and is written in FORTRAN IV, permitting six chemical elements to be determined simultaneously without redimensioning the program.

The relative X-ray intensity data are corrected for atomic number, absorption, and secondary fluorescence due to characteristic lines. The program includes options for calculating the mass fraction of one chemical element by difference or by stoichiometry.

The concepts and models for data reduction that are applied in this technique were first described in NBS Technical Note 521.

Technical Note 719 may be ordered prepaid from the Superintendent of Documents, Washington, D.C. 20402 at 55 cents each.

HumRRO Publishes Four Technical Reports

Four new technical reports have been published and distributed by the Human Resources Research Organization (HumRRO).

They are: TR 72-14, "Driver Education Task Analysis: The Development of Instructional Objectives," for the Department of Transportation; TR 72-16, "Training in Mechanized Stock Accounting Systems in Army Logistics," for the Department of the Army; TR 72-17, "Reenlistment Intentions of Tank Commanders," for the Department of the Army; and TR 72-18, "Summary and Review of Studies of the VOLAR Experiment, 1971: Installation Reports for Forts Benning, Bragg, Carson, and Ord, and HumRRO Permanent Party Studies," for the Department of the Army.

HONORABLE Robert L. Johnson, Assistant Secretary of the Army (Research and Development), is greeted at the U.S. Army Aviation Systems Command (AVSCOM), St. Louis, Mo., by BG Samuel G. Cockerham, AVSCOM deputy CG. Secretary Johnson visited AVSCOM for briefings on several R&D programs.

BESRL Report Describes Gisting Tests

Titled "A Comparison of Two Methods of Gisting" is a new U.S. Army Behavior and Systems Research Laboratory (BESRL) report that describes tests conducted with 24 communications processors.

In both methods, the subject listened to the complete message one time with no option to stop or replay, preparing as complete a gist as he could.

In one method, he was free to replay the message, starting and stopping as he judged necessary to complete the gist (free repeat). In the other method (forced repeat), the subject listened to the complete message five additional times with no option to stop or replay.

Technical Research Note 236, evaluating both methods, is available from: U.S. Army Behavior and Systems Research Laboratory, ATTN: RDMR-BLZ, 1300 Wilson Blvd., Arlington, Va. 22209.

HumRRO Reports Pictorially on 'VOLAR Country'

A sign emblazoned with "VOLAR COUNTRY, Where the American Fighting Man Starts" graces the cover of a new pictorial report by the Human Resources Research Organization (HumRRO).

The report describes a recent effort in developing and evaluating EVATP (Experimental Volunteer Army Training Program). The EVATP applies six applied principles: performance-oriented instruction, learning in a functional context, self-pacing in the learning process, an insistence on mastery, feedback to both student and instructor, and strict quality control.

"The Experimental Volunteer Army Program: A Pictorial Report" was prepared by HumRRO Division No. 3, P.O. Box 5787, Presidio of Monterey, Calif. 93940. Copies are available on request.

Tech Papers Report on Watervliet Research

Watervliet Arsenal research is the subject of two papers published in the current issues of *Plating* and the *Journal of Basic Engineering.*

Dr. Fritz K. Sautter, who heads the Physical Science Division, and chemical engineer John C. Sadak are the authors of the *Plating* article, "Effect of Plating Variables of Deposit Composition in a Watts-Type Cobalt-Nickel Electrolyte." The paper describes the electroforming of high-temperature alloys for ordnance materiel, and specifically, automating the process of alloy plating.

David P. Kendall, a mechanical engineer, prepared the *Journal of Basic Engineering* paper, "The Effect of Strain Rate and Temperature on Yielding in Steels," which is derived from research in the Materials Engineering Division.

CERL Saves $3 Million by Antipollution Study

Design criteria for solution of pollution problems in manufacturing at Holston Army Ammunition Plant in Kingston, Tenn., at a cost $3 million less than solution methods earlier proposed, are credited to a Construction Engineering Research Laboratory study.

CERL, a U.S. Army Corps of Engineers element at the University of Illinois, was requested to study air and water pollution and solid waste problems at the plant.

Proposed solutions included the use of molecular sieves for controlling oxides of nitrogen released by ammonia oxidation processes; biodegradation of industrial waste water; and thickening of sand bed filtration and landfill to eliminate water treatment plant sludge.

These solutions, developed by CERL's Electromechanical and Environmental Systems Division in coordination with the U.S. Environmental Protection Agency, the Army Environmental Hygiene Agency, and State of Tennessee officials, satisfy existing federal and state control requirements.

The plant in Kingsport is the only U.S. producer of RDX and HMX explosives. Its output goes to military munitions manufacturers and to NASA for the space program.

The Mobile District of the Corps of Engineers, which has the responsibility of designing and constructing pollution control facilities at Holston, engaged CERL to conduct the comprehensive technical evaluation.

Awards . . .

MERITORIOUS CIVILIAN SERVICE. William J. Balderson, assistant chief of the Logistics and Facilities Division, Office of the Surgeon General, recently received the Meritorious Civilian Service Award (MCSA), the Army's second highest award for civilian employes.

The citation states: "His outstanding logistical knowledge, executive competence, leadership ability and vision materially contributed to medical facility planning and logistical support of the essential health care delivery system within the Army Medical Department."

John F. Hand, deputy to the Land Combat Special Items Manager, Redstone (Ala.) Arsenal, received the MCSA for his role in establishing policies, budgets and logistics support for the TOW and Shillelagh missile systems which contributed to their deployment ahead of schedule.

MG Edwin I. Donley, CG of the U.S. Army Missile Command, presented the award.

Billy C. Lucas, chief, Programs and Policies Group, Directorate of Resources Management, Office of the Surgeon General, where he has served for 15 years, was presented the MCSA. The citation praised his "expert monitorship" of Army Medical Department programs, contributing to the maintenance of effective and efficient medical services.

LEGION OF MERIT. *COL James E. Cassidy,* DC, was awarded the Legion of Merit (LM) upon his retirement after 24 years of Army service, the last four as chief of the Professional Branch for the Army Dental Corps.

The award recognized his initiative and imagination in streamlining dental services and for developing a new concept of resources management designed to help solve the oral disease problems in the Army.

MERDC Retiree Receives CO's Dual Award

Turner G. Timberlake, one of the U.S. Army Mobility Equipment Research and Development Center's most frequently honored employes, recently was presented the first combined Commanding Officer's Leadership and Technology Achievement Award.

COL Bennett L. Lewis, CO of the MERDC, made the presentation when Timberlake retired with 30 years of civilian-military service.

Timberlake was his associate deputy for engineering and earlier served as chief of the Mechanical Technology Department, then as chief of the Engineering Department. COL Bennett cited his contributions to the Engineering for Procurement Program.

Timberlake holds a BS degree in mechanical engineering from the University of Maryland and has authored and coauthored more than a dozen technical papers on earthmoving, construction and materials-handling equipment.

COL Bruce W. Jamison, former chief of the Test Division, deputy president and president of the U.S. Army Armor and Engineer Board, Fort Knox, Ky., received the LM for exceptionally meritorious conduct during the period 1969–72. MG Charles P. Brown, CG of the U.S. Army Test and Evaluation Command, made the presentation.

BRONZE STAR MEDAL. *LTC (Dr.) Janice Mendelson,* MC, OTSG, director of the tri-service Military Blood Program Agency, was awarded the Bronze Star Medal (BSM) for service as surgical adviser in the Office of the Command Surgeon, U.S. Military Assistance Command, Vietnam. Dr. Mendelson is the only Board Certified woman surgeon on active duty with the Army Medical Department.

MAJ Chauncy P. Brothers, MSC, assigned to the Facilities Branch in the Directorate of Plans, Supply and Operations, OTSG, received the BSM for his duties as executive officer, 91st Evacuation Hospital in Vietnam in 1971. The citation recognizes his outstanding performance following a typhoon disaster.

MAJ John E. Roberts, MSC, chief of the Organization Section, Force Development Division in the Directorate of Plans, Supply and Operations, OTSG, is the recipient of the BSM for service in Vietnam prior to his present assignment in Washington, D.C.

MAJ Donald F. Straetz, International Division, Office of the Chief of Research and Development, HQ DA, received the BSM for 1971–72 service in military operations against a hostile force in Vietnam.

He served as chief, Budget and Plans Branch, Ordnance Advisory Division, Logistics Advisory Directorate, J-4 Headquarters, U.S. Military Assistance Command. LTG William C. Gribble Jr., Chief of Research and Development, presented the award.

MERITORIOUS SERVICE MEDAL. *COL Edith J. Bonnet,* assistant chief, Army Nurse Corps, was recently awarded the Meritorious Service Medal (MSM) for her prior service as chief, Nursing Division, U.S. Army Medical Command, Europe.

BG Lillian Dunlap, chief of the Nurse Corps presented the award in the Office of the Surgeon General (OTSG), Washington, D.C.

COL Kenneth R. Wilson, MSC, former director of Professional Services, OTSG, was presented the MSM prior to his departure to attend the Industrial College of the Armed Forces, Washington, D.C.

BG Thomas J. Whellan Jr., special assistant to The Surgeon General for Medical Corps Affairs, made the presentation which recognized COL Wilson for his "exceptional competence" in handling Medical Corps affairs.

LTC William P. Farmer, now assigned to the Management and Test Division, Office of the Chief of Research and Development, HQ DA, was recently awarded the MSM for his 1970–71 service as battalion commander, 1st Battalion, 30th Artillery, U.S. Army Field Artillery Center and Fort Sill, Okla. The citation recognizes his efforts in increasing reenlistment rates and setting an example for other field artillery commanders.

MAJ Roland F. Seylar, of the U.S. Army Engineer Power Group, Fort Belvoir, Va., received the MSM for his service to the Korean Army. COL Harvey L. Arnold Jr., director of the Engineer Power Group, presented the medal to MAJ Seylar, citing his 1970–71 service as engineer adviser to the III Corps and engineer supply and maintenance adviser to the First Republic of Korea Army.

ARMY COMMENDATION MEDAL. *LTC John J. White,* MSC, health educator in the Preventive Medicine Division, Directorate of Health and Environment, OTSG, received the third Oak Leaf Cluster to the Army Commendation Medal (ARCOM).

The citation praised his managerial and technical proficiency and dedication in seeking improvement of the U.S. Army Medical Command support mission in Europe while serving (1970–72) as chief of the Force Structure Division, Office of the Assistant Chief of Staff for Intelligence and Operations.

MAJ Jessie Stuart Brewer, the first Army Medical Specialist Corps officer to attend the Army Command and General Staff College, recently received the ARCOM for 1970–72 service as assistant chief, Food Service Division and chief, Production and Service Branch at Fitzsimons General Hospital. She is presently serving as OTSG food service systems officer.

MISCELLANEOUS AWARDS. Dr. Ingo W. May, a research chemist with the Interior Ballistics Laboratory, U.S. Army Ballistic Research Laboratories, Aberdeen (Md.) Proving Ground, recently received a $295 Special Act or Service Award for his contributions and support of a study on propellants and related propulsion systems.

BULLETIN BOARD . . .

BESRL Study Shows ACB Tests Fair to All

Are selection and classification tests used in the Army fair to members of minority groups? An Army study by the Behavior and Systems Research Laboratory indicates "yes."

Research was conducted by Dr. Milton H. Maier under BESRL Director Dr. J. E. Uhlaner to explore the meaning of aptitude test scores for groups varying in general mental ability, in education, and in race (Technical Research Note 228). Army Classification Battery (ACB) scores of over 17,000 men who entered the Army in a typical month were analyzed.

Conclusion: Tests of the ACB measure the same kinds of aptitudinal characteristics, whether the men are blacks or whites, high school dropouts or high school graduates, or whether below average, average, or above average on general mental ability.

Further, there were no discernible differences in characteristics for cross-classifications such as race by level of education or race by level of general mental ability.

Conclusions are based upon comprehensive statistical analysis of patterns of test interrelationships across subgroups. The minority groups did, on the average, score below the majority groups on all tests. Differences in scores were about as expected from previous research. The differences do not mean, however, that the tests are measuring different things in the different groups.

Two clearly identifiable academic and mechanical test patterns were found in all subgroups. Academic tests included measures of word knowledge, arithmetic reasoning, and general information. Mechanical tests included measures of automotive information, electronics information, mechanical comprehension, and information about skilled trades.

Particular attention was given black high school dropouts and blacks with below-average mental ability, with respect to reading requirements.

Do paper-and-pencil tests that require reading measure the same characteristics for these groups as for, say, white high school graduates or whites with average ability? Again, the answer is yes.

Tests that require reading as compared to those that do not, such as visualizing geometric forms and patterns, or learning to receive International Morse Code, showed the same pattern of test interrelationships across the groups. Thus, the reading requirement does not seem, by itself, to be a barrier for minority groups in respect to these areas.

Army May Adopt Noise Pressure Standard

Possible adoption of an Army standard for permissible noise pressure will be discussed Sept. 15 by representatives of the Office of the Suregon General, Army Materiel Command (AMC) and Combat Developments Command.

AMC personnel will include representatives from the Human Engineering Laboratories (HEL) at Aberdeen (Md.) Proving Ground, where the meeting will be held. Researchers at HEL have been investigating noise in Army materiel for more than a decade to try to set acceptable levels.

Sound pressure level is measured in decibels over an audio range predominantly from 75 to 8,000 hertz. Measurement is made at numerous points along the frequency range and the total result is then used to calculate the over-all noise level.

The OTSG presently considers 85 db the maximum permissible noise level, and that higher sound levels must be accompanied by hearing protection devices. Exposure to excessive noise may cause either temporary or permanent hearing loss.

HEL technicians are presently working on various protective helmets, ear muffs and ear plugs. One of the problems they have encountered is the fact that ear plugs and muffs do not give complete protection; sound may also enter the body through the nose and mouth and skeleton.

A further problem is that protection is not linear; as sound frequency drops it carries more energy and requires more effective protection.

Feature articles on HEL's early noise level research program appeared in the 1965 January and October issues of *Army Research and Development Newsmagazine.*

ECOM Reorganization Enters Second Phase

Reorganization of the U.S. Army Electronics Command (ECOM) directed by the Army Materiel Command (AMC) and partially implemented in June 1971, will soon enter another phase at Fort Monmouth, N.J.

MG Hugh G. Foster, ECOM CG, said a change into a standard commodity command alignment was directed to achieve greater uniformity of structure throughout the Materiel Command.

ECOM's upcoming action will involve the transfer of the bulk of the command's production engineering functions and personnel from the Procurement and Production Directorate to the Directorate of Research, Development and Engineering. Some personnel are being moved to the Directorate of Product Assurance.

MG Foster said the internal realignment will ensure closer teamwork between the development engineer and the production engineer and thereby enhance ECOM's primary mission accomplishment. No reduction in force is anticipated, although some changes in grade could result.

MG Foster confirmed two other organizational changes involving ECOM. The first will establish a 12-person Product Manager's Office for Mortar and Artillery Radars at Fort Monmouth.

Certain communications security (COMSEC) logistics functions now the responsibility of the Army Strategic Communications Command (STRATCOM) at Fort Huachuca, Ariz., are being transferred to ECOM. There are "paper" transfers only and do not involve the physical movement of any personnel.

SCIENTIFIC CALENDAR

National Aerospace Engineering and Manufacturing Meeting, sponsored by SAE, San Diego, Calif., Oct. 2–5.

8th International Symposium on Remote Sensing of Environment, Ann Arbor, Mich., Oct. 2–6.

Tri-Service Gun Propellant Symposium, sponsored by AMC, Navy and AF, Dover, N.J., Oct. 3–5.

1st International Noise Control Engineering Conference and Equipment Exposition, sponsored by EPA, Dept. of Labor, Dept. of Transportation, Dept. of HEW, Dept. of HUD, NBS, INCE, ASA and ICA, Washington, D.C., Oct. 4–6.

15th Organic Chemistry Conference, sponsored by AMC, Natick, Mass., Oct. 5–6.

Systems Science and Cybernetics Conference, sponsored by IEEE, Washington, D.C., Oct. 8–11.

International Symposium on Chemiluminescence, sponsored by ARO-D and ONR, Athens, Ga., Oct. 9–13.

Fall Meeting of Research and Development Associates for Military Food and Packaging Systems, Natick, Mass., Oct. 10–11.

International Telemetering Conference, Los Angeles, Calif., Oct. 10–12.

1st Pacific Chemical Engineering Congress, sponsored by AICE, Kyoto, Japan, Oct. 11–14.

Electronic and Aerospace Systems Convention, sponsored by IEEE, Washington, D.C., Oct. 16–18.

6th Data Exchange for Inertial Systems, Tobyhanna, Pa., Oct. 17–18.

Fall Meeting of Society for Experimental Stress Analysis, Seattle, Wash., Oct. 17–20.

International Electron Devices Meeting, sponsored by IEEEE, Washington, D.C., Oct. 18–20.

International Symposium on Systems Engineering and Analysis, Lafayette, Ind., Oct. 23–27.

18th Conference on the Design of Experiments in Army Research, Development and Testing, sponsored by ARO-D, Aberdeen Proving Ground, Md., Oct. 25–27.

Engineering Management Conference, sponsored by IEEE, Atlanta, Ga., Oct. 29–31.

20th Joint Engineering Management Conference, Atlanta, Ga., Oct. 30–31.

International Symposium of International Society for Hybrid Microelectronics, Washington, D.C., Oct. 30–Nov. 1.

21st Defense Conference on Nondestructive Testing, San Antonio, Tex., Oct. 31–Nov. 2.

Environmental Resources Conference, sponsored by EPA, NSF and Battelle Columbus Labs, Columbus, Ohio, Oct. 31–Nov. 2.

Soviet Scientists Discuss Research at CRREL

Two Soviet polar scientists recently visited the U.S. Army Cold Regions Research and Engineering Laboratory (USACRREL) to discuss research being conducted in the Artic and Antartica. They also presented the laboratory a medal commemorating the 250th anniversary of the first Russian landing in Antartica. Shown making the presentation to COL J. F. Castro (center), USACRREL CO and director, is P. K. Sen'ko (left), and V. A. Shamot'yev looks on. The Russians were on an 18-day visit to U.S. organizations conducting polar studies.

Remotely Piloted Vehicles

MASSTER to Evaluate Canadian CL-89 Drone Aircraft As Search for High-Performance RPV System Resumes

Remotely piloted vehicles, absent from the Army since 1966, will reappear this fall when the Canadian CL-89 Drone is tested by MASSTER (Modern Army Selected Systems Test, Evaluation and Review.

The CL-89 drone, a component of the AN/USD-501 Surveillance Drone System, is being considered to fulfill a Combat Developments Command requirement for a relatively simple, low-cost, high-performance remotely piloted vehicle.

The Army expects the ultimate system to provide point or small area surveillance for tactical intelligence information within a division commander's area of control; also, to provide a capability to point a target with a laser beam for acquisition by laser-guided missiles.

BG Wilbur H. Vinson Jr., director of Plans and Programs, Office of the Chief of Research and Development (OCRD), explained:

"The advent of laser-guided weapons and the prospect of a high-intensity, sophisticated air defense environment has surfaced a requirement for a surveillance and targeting RPV (remotely piloted vehicle)."

Addressing a recent Symposium on Remotely Piloted Vehicles in Washington, D.C., BG Vinson added: "We visualize the RPV as essentially a remote forward observer vehicle that, in addition to real-time surveillance and conventional targeting, could provide the laser designation function for the Hellfire and cannon-launched guided projectiles out to ranges of 25 kilometers."

CDC studies indicate that from the FEBA (Forward Edge of the Battle Area) to a depth of 25 kilometers, the Army requires sustained surveillance of the battlefield under all environmental conditions.

Recognized also is a need to reconnoiter areas that are masked by terrain from ground and airborne radars to a depth of 100 kilometers. Detecting, identifying and locating critical targets in areas covered by enemy air defense weapons is another mission expected to be facilitated by the RPV.

Presently, the Army's principal aerial surveillance vehicle is the OV-1 Mohawk equipped with side-looking airborne radar, infrared and photographic sensors.

Considered the best reconnaissance and surveillance system in the Army today, the OV-1 provides only limited target acquisition information for corps, divisions and lower echelons. This is because of positioned accuracy restrictions and reduced penetration capability.

A drone system, on the other hand, is expected to augment the OV-1—providing accurate target information to the tactical units in sufficient detail to enable commanders to bring immediate, responsive firepower against enemy targets.

Army studies of the enemy air defense threat indicate that troop areas and other targets will be heavily defended, making manned reconnaissance, surveillance and target acquisition systems vulnerable to prohibitive losses.

Both the CDC and the Army Materiel Command (AMC) consider the same three specific missions for RPVs in future planning. Two are oriented toward surveillance while the third concerns target acquisition.

In AMC's consideration, RPVs can be used effectively for reconnaissance and to generate hard copy imagery. The latter would give a detailed picture of specific areas on the ground which may have been highlighted by the continuous surveillance system or some external intelligence source.

An RPV performing reconnaissance this way can obtain more complete coverage of smaller, selected areas on the ground that could reveal military targets. This information, plus other sources of intelligence, could initiate target acquisition missions with another RPV.

By remaining in the target area, RPVs also can facilitate post-strike damage assessment after substituting for forward observers in locating targets and adjusting the fire of ground artillery against the enemy.

To fulfill the surveillance mission, a drone is expected to be configured for high-altitude flight. Continuous surveillance would be provided by a stand-off drone flying behind the FEBA, mounted with a long-range radar to furnish data to a ground station.

A technical approach to this type of RPV system is currently being explored under a program known as ALARM (Alerting Long Range Airborne Radar for MTI). Although current exploratory work with ALARM is being carried out in a manned aircraft, AMC considers that its potential as a continuous surveillance system can probably be better achieved with an unmanned aerial platform.

Reconnaissance missions, however, can be accomplished with a small, high-speed RPV that penetrates enemy air space, secures intelligence by flying over preselected areas, and returns to base in the shortest time.

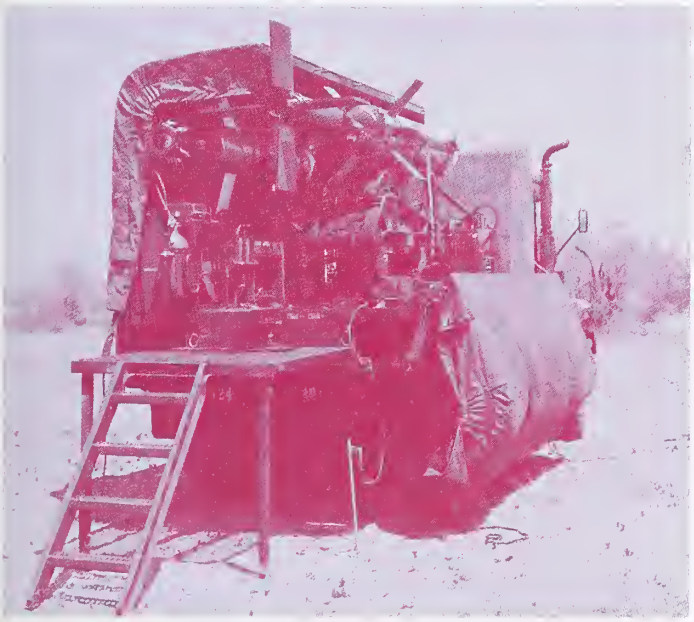
High-resolution imagery can then be extracted from a photographic camera or an infrared scanner recovered with the drone. A candidate system for this type mission is the AN/USD-501, more commonly known as the Canadian CL-89 Drone.

In the prototype planning stage is the RPV system for the target-acquisition mission. This RPV would carry an imaging sensor, for day and night operation, to provide a real-time picture to a ground station.

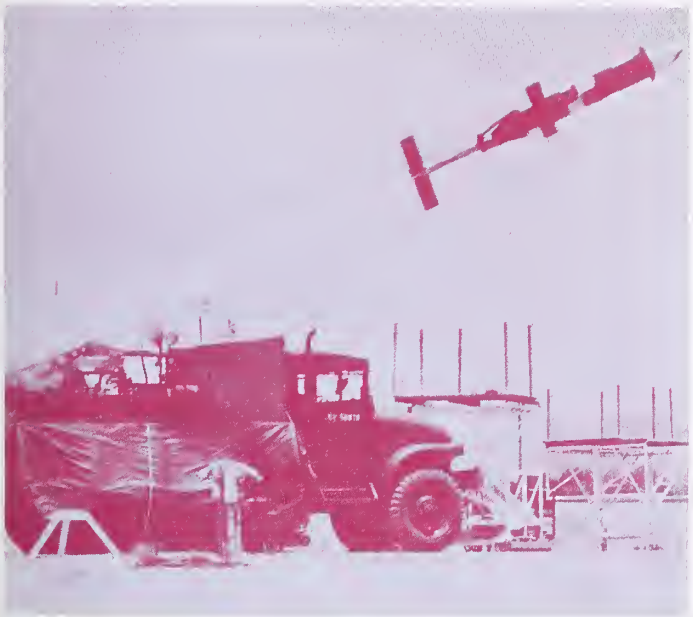
This drone system has the most difficult role to perform in terms of survival since it must penetrate enemy air space and remain on station long enough to carry out target-acquisition processes. Its vulnerability would be increased by additional loiter time needed for artillery fire adjustment and post-strike damage assessment.

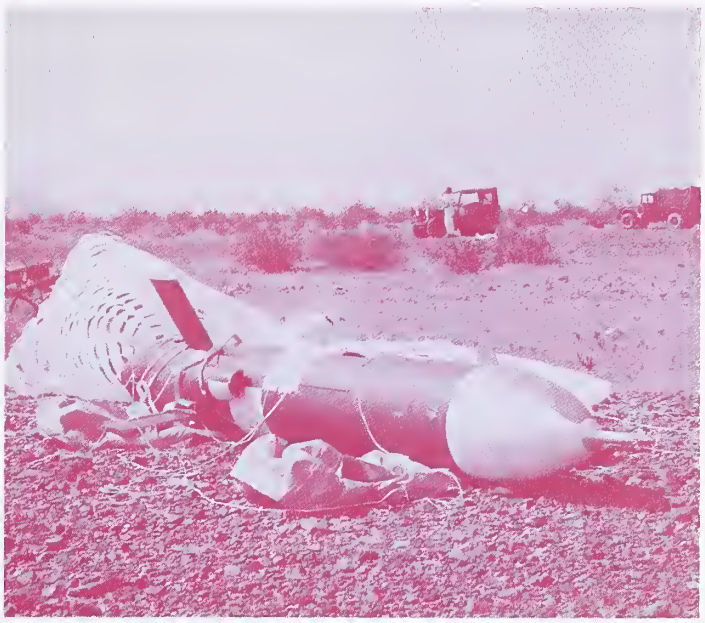
Success in fulfilling the Army's reconnaissance, surveillance and target acquisition missions on the battlefield depends in large measure on overcoming technological problems evident in past drone systems.

The CL-89 Drone tests will comprise a first step in the development of RPVs for use by the Army.



RPAODS (Remotely Piloted Aerial Observer/Designator System) portrays a target acquisition drone system used in direct support of weapons systems to engage ground targets. Under ground control, the drone is directed to a target area. It searches and transmits the scene to a ground control station where an operator views the picture and selects the target to be engaged. An experimental model of the ALARM (Alerting Long-Range Airborne Radar for Military Target Information) in flight is shown at top right. The functional elements include a helicopter-borne, high-resolution radar and a ground-based processing and display facility. At left is a 2½-ton, M-135 truck installation, consisting of a launcher that carries one CL-89 drone and a launch support vehicle that carries three drones and ancillary stores. Shown below is a CL-89 launch from the truck installation, and a 2-stage parachute recovery system used with two air-filled bags to absorb the landing shock and prevent damage.





ATMOSPHERIC SCIENCES PROGRAM

FY 70 | FY 71 | FY 72 | FY 73 | FY 74 | FY 75 | FY 76 | FY 77 | FY 78 | FY 79 | FY 80 | FY 81 | FY 82 | FY 83 | FY 84 | FY 85

SECOND GENERATION AMS-85

METEOROLOGICAL SATELLITE APPLICATIONS

FLARE

ATMOSPHERIC SENSING

FOG DISPERSAL

WARM FOG

COLD FOG

REAL-TIME METEOROLOGICAL SUPPORT FOR COMBAT OPERATIONS

FIRST GENERATION AMS-75

CAPABILITY

ATMOS ENV BMD SYSTEMS

THEORETICAL STUDIES IN SITU MEASUREMENTS

NUCLEAR BLACKOUT

WEAPONS SYSTEMS

REGIONAL CLIMATOLOGY

PROGRAM BASIC RESEARCH BASE

CLOUD PHYSICS

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BOUNDARY LAYER STUDIES

BALLISTIC METEOROLOGY

ELECTRICAL PROPERTIES

MESOMETEOROLOGY

IONIZATION

METEOROLOGICAL DATA SOUNDING SYSTEM AN/UMQ-7( ) (V)

FSS CCIS 70

FDC

LAUNCHER

GENERATOR 400 CPS

MOBILE HYDROGEN GENERATOR

AUTOMATIC ATMOSPHERIC SOUNDING SET AN/TMQ-19

INFLATION-LAUNCHING DE

BASELINE CHECK SET

MET OBS. SET (VIBALL)

TYPICAL ARTILLERY METRO SECTION